KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
SIMPLY WORDED—EXACTLY DESCRIBED

LONDON: FEBRUARY 1, 1895.

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EDITORIAL NOTE.

THE lamented death of Mr. A. COWPER RANYARD renders new arrangements necessary for the conducting of KNOWLEDGE. It is due to the readers of the Magazine to state broadly what these arrangements will be.

The pages devoted to Astronomy will be edited for the present by Mr. E. WALTER MAUNDER, Hon. Sec., Royal Astronomical Society, who has already received hearty assurances of help from several leading astronomers, both at home and abroad. Various plates, of equal merit with any that have previously appeared, will be issued during the year.

The old staff of writers will continue to give their valued support to the Magazine, and fresh writers will render it their help. The Magazine will maintain its present high character and will continue to be generously illustrated, while efforts will be made to render it, if possible more attractive to the general reader.

ARTHUR COWPER RANYARD AND HIS WORK.

By W. H. WESLEY, *Assist. Sec., R.A.S.*

OUR readers have already learned the severe loss which has been sustained, not only by this journal but by science, in the death of our late esteemed Editor, Mr. Arthur Cowper Ranyard.

He was born on June 21st, 1845, at Swanscombe, Kent. His mother was well known for her philanthropic work, and for her writings on religious subjects, under the signature of "L.N.R." The family removed to London during Mr. Ranyard's youth, and he was at University College School from 1857 to 1860, after which he attended Prof. De Morgan's classes at University College, and formed an intimate friendship with the son of the professor, Mr. George De Morgan. In 1864 the two young men formed the plan for a society for the study of mathematics, and a circular, signed by both as "Hon. Secs. *pro tem.*," was issued, inviting attendance at the first meeting of "The University College Mathematical Society." The first meeting was held on January 16th, 1865, when Prof. De Morgan was elected president, and Messrs. Cozens-Hardy and Bompas secretaries. At this meeting Mr. Ranyard read the first paper, "On Determinants." Being supported by Prof. De Morgan and other eminent mathematicians, the association flourished, and has grown from a students' society into the present "London Mathematical Society." Mr. Ranyard left the Council soon afterwards, as he was proceeding to Cambridge, where he entered Pembroke College, and took his degree of B.A. in 1868.

He had already been elected a Fellow of the Royal Astronomical Society in 1863, at the early age of eighteen, and in 1872 became a member of the Council, on which he remained, with an interruption of only four years, till the time of his death. From 1874 to 1880 he filled the office of honorary secretary, for which he was especially fitted from his ability, industry, and invariable courtesy.

Entering the legal profession, he was called to the bar in 1871, since which time, though engaged in practice, his love for science led him to devote most of his spare time to the study and promotion of astronomy.

In 1870 a joint committee of the Royal and Royal Astronomical Societies organized an expedition to Sicily for the observation of the total solar eclipse in the December of that year, Mr. Lockyer being secretary and Mr. Ranyard assistant secretary to the expedition. The weather was, unfortunately, unfavourable, the sky being more or less obscured at all the stations, but at Villasmunda Mr. Ranyard made a very successful series of polariscopic observations.

After his return he was requested by the late Sir George Airy to assist in the serious task of collating and systematizing the observations of the eclipses of 1860 and 1870. The work, as it proceeded, greatly extended its scope, and ultimately devolved upon Mr. Ranyard alone. The outcome was the great eclipse volume of the Royal Astronomical Society, in which are given and discussed the results of all known eclipse observations down to 1878. The labour involved was very great, more than a year being occupied in cataloguing the details visible upon the corona photographs of the eclipse of 1871, and the work was only finished at the end of 1879.

His experience in the examination of eclipse photographs led him in 1872 to undertake, in conjunction with Lord Crawford, a series of experiments on photographic irradiation, the phenomena of which were separated from those caused by reflection from the back of the plate, and shown to arise from imperfections in the optical image, and not

from chemical action within the film. In 1886 Mr. Ranyard made a series of comparatively rough experiments, the results of which appeared to show that the intensity of photographic action varies directly as the brightness of the object photographed, and directly as the time of exposure.

In 1878 Mr. Ranyard went, at his own expense, to Colorado, to observe the total eclipse of July 20th, taking with him a large camera of thirteen inches aperture and six feet two inches focal length, with the view of taking photographs of the corona on a larger scale than any hitherto obtained. He joined Prof. Young's party at Cherry Creek, near Denver, and was successful in observing the eclipse, though, owing to an accident during the exposures, he only obtained two photographs of the corona, and these of too short an exposure to show any corona beyond six or seven minutes from the limb. He also made spectroscopic and polariscopic observations. The account of the expedition is given in Vol. XLVI. of the *Memoirs* of the Royal Astronomical Society. In 1882 he went to Sohag, in Upper Egypt, and observed and photographed the total solar eclipse of May 17th, but his observations were never published.

In 1888 his friend Mr. R. A. Proctor died, leaving his great work, "Old and New Astronomy," still incomplete. This work Mr. Ranyard undertook to finish. He revised, completed, and published the chapters on the planets, and, as Mr. Proctor had written nothing of the section treating of the universe of stars, the distribution of the nebulæ, and the construction of the Milky Way, the chapters on these subjects are from Mr. Ranyard's pen alone. They are undoubtedly some of the most original and valuable in the book, which was finally issued in its complete form in 1892. It was characteristic of his unselfish and generous spirit that he should thus devote years of hard work to sustain the reputation of his friend, and with no thought of reward for himself. But he always rejoiced in another's success, and felt the labour to be no sacrifice.

Mr. Ranyard succeeded Mr. Proctor as Editor of KNOWLEDGE, and our readers know with how much zeal and ability this journal has been conducted by him. He performed a great service in reproducing the long series of celestial photographs which have appeared in our pages, thus placing within the reach of all some of the results of the achievements of Dr. Roberts, Prof. Barnard, Mr. Russell, and many others. His own original contributions upon the constitution of the heavens—the Milky Way, nebulæ, star clusters, the moon, &c.—have been of great value, while his acute but always kindly criticisms upon the contributions of others have been a welcome feature. To his papers in this journal he devoted his most earnest thought, and in many of them may be found the expression of his mature views upon the intricate and perplexing problems with which he dealt. We may particularly specify his series of articles entitled "What is a Nebula?" and "What is a Star Cluster?"—profusely illustrated by reproductions of photographs. He himself considered as his most important contribution to these questions his investigations on the density of nebulæ, and the conclusion at which he arrived, that the density of the Orion Nebula cannot exceed the ten thousand millionth of the density of atmospheric air at the sea level. He recognized a close analogy between irregular nebulæ and star clusters, and was strongly convinced that in both these structures the matter is ejected from the centre, mostly into a resisting medium, and is not condensing *towards* the centre, as assumed by Laplace's theory. Mr. Ranyard's work on KNOWLEDGE went on almost to the last, and probably his latest scientific writing was a note to Mr. Gore's letter in our November number.

In his work on solar physics, which had always appealed strongly to him, he was especially assiduous in his study of the details of the corona, and was firmly convinced that their forms bore witness to matter ejected from the sun into a resisting medium, though not, of course, into an atmosphere in any sense comparable with our own. He carried the experience derived from his solar studies into his work on stars and nebulæ, and was always quick to perceive coronal analogies in the details of their structure. He was very desirous to enter upon the new fields of research opened by Hale and Deslandres, and had a spectro-heliograph constructed, which he lent to Prof. Hale for his expedition to Mount Etna, as the state of his own health did not permit him to accompany his friend, as he had intended.

Mr. Ranyard was an excellent linguist, and through the whole of his scientific life maintained intimate relations with most of the leading astronomers in Europe and America. In his earlier life he was the friend of Argelander, Donati, Secchi, and Young, and afterwards of Barnard, Hale, Max Wolf, and many others.

In politics Mr. Ranyard was an ardent Individualist, and was a warm supporter of the efforts made by the Hon. Auberon Herbert and others in favour of greatly restricting the sphere of Government interference with private activity. Though taking but little interest in party politics, his intense conviction of the evil of socialistic legislation led him naturally to conservatism. He was much impressed with the evil results arising from the growing tendency of men of education and culture to keep aloof from municipal affairs, and to neglect the performance of civic duties. His keen interest in all social questions led him, in 1892, to become a candidate for the London County Council. He was returned at the head of the poll for the Holborn division, in which he and his colleague, Mr. Remnant, represented the Moderate interest. At the Council, Mr. Ranyard's legal knowledge, as well as his earnestness and high character, made him an influential member, and his zeal led him to greatly overtax his strength. In the year ending March, 1893, he had attended every meeting of the Council, and almost every meeting of the various committees and sub-committees of which he was a member. He was especially interested in the Parliamentary and Building Acts Committees, and in the latter he did his most important work in fighting for the new (London) Building Act, which passed the Houses of Parliament last summer. In support of this Bill he appeared and gave evidence before a Select Committee of the House of Commons.

As far back as last June he was not in his usual health, and began to experience a loss of weight and strength. As months went by, the symptoms became more pronounced: he became steadily weaker, and found increasing difficulty in digestion. Change of air was tried without effect, and the symptoms increased in severity till, in October, the presence of some serious internal disorder was suspected. Medical opinions were, however, not unanimous, and it was not till latterly that the complaint was definitely pronounced to be an internal cancer. He died after much suffering on December 14th, at the comparatively early age of forty-nine.

He was always outspoken and fearless in the expression of his opinions, but those most opposed to him were most ready to admit the high sense of duty and absolute conscientiousness by which he was guided. Entirely without self-seeking, always courteous, and ever ready with advice and assistance, he maintained most cordial relations with his coadjutors and correspondents, and his death leaves a gap in the ranks of English amateur astronomers

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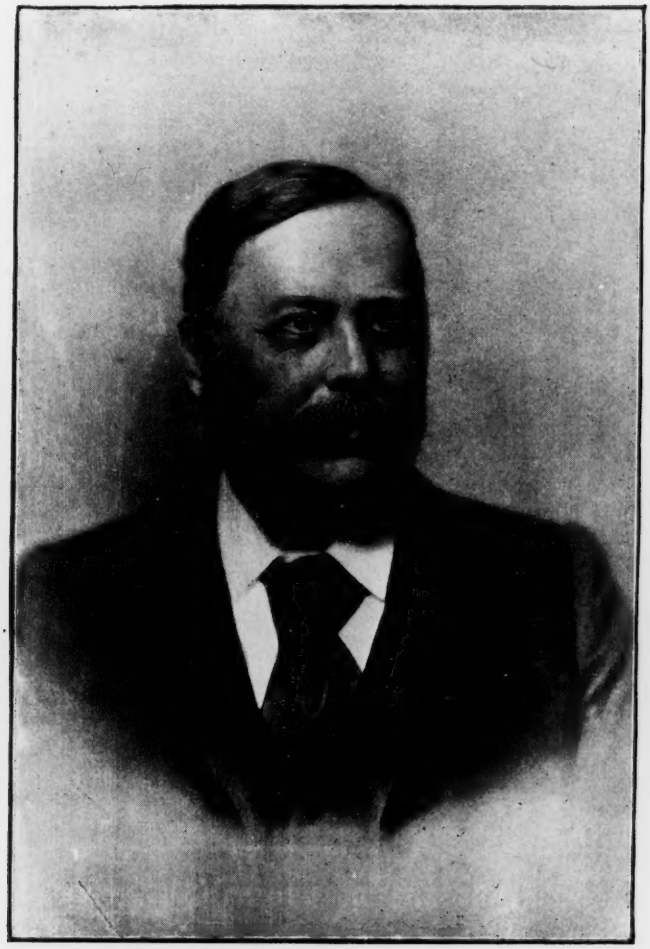

The late ARTHUR COWPER RANYARD.

Editor of KNOWLEDGE.

From a Photograph, by kind permission of M. Van der Weyde.

Knowledge, February, 1895.

Frontispiece of Volume.

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which will not be soon filled up. But it is not only by his colleagues, and in the scientific world that his loss will be keenly felt. His kindly disposition, his many acts of unostentatious benevolence, and his readiness to take trouble for the good of others, endeared him to a wider circle, which, but for his habits of assiduous labour, would have been wider still.

THE SMALLEST FLYING SQUIRREL.

By R. Lydekker, B.A.Cantab., F.R.S.

It is a somewhat remarkable fact in natural history that while all the true flying mammals, that is to say bats, belong to a single ordinal group, and, for all we know to the contrary, may have been derived from one original ancestral stock, this is very far from being the case with those creatures coming under the popular designation of flying squirrels. As we have had occasion to point out in a previous article published in this journal, bats have their fore-legs and fingers specially modified for the support of their peculiar leathery wings, and are able to fly in the same manner as birds; whereas all the flying squirrels have no such modification of the skeleton, and are merely enabled to take long flying leaps from tree to tree by a parachute-like expansion of the skin of the sides of the body, which is supported between the fore and hind limbs of each side, and in some cases extends between the latter to embrace the root of the tail.

In popular natural history the term "flying squirrel" is taken to include certain mammals endowed with this kind of spurious flight inhabiting North America, Asia, Africa, and Australia. So like, indeed, in general external appearance are all these creatures, that it is not surprising to find them all confounded under one general title. When, however, they are examined with the critical eye of an anatomist, they are found to arrange themselves in three main groups, two of which are much more nearly allied to one another than is the third to either of them.* This third group, which is confined to Australia and some of the neighbouring islands, has really no right to the name of flying squirrels at all, seeing that it belongs to the order of pouched or marsupial mammals, and has teeth of a totally different type to those characterizing all the rodent order, of which the flying squirrels properly so called are members. Accordingly, since these Australian creatures are allied to the ordinary phalangers of the same region, they are more properly spoken of as flying phalangers; and by this name we shall allude to them in the course of the present article.

Since these flying phalangers belong to the marsupial order, while the flying squirrels are rodents, it will of course be perfectly evident that they have no sort of genetic connection with one another, and hence that their flying membranes have been developed quite independently. If this were all it would be a very remarkable instance of that "parallelism in development" to which we have alluded in previous articles,† seeing how strikingly similar in external appearance are the members of the two groups. The marvel does not, however, by any means rest here; since it has been shown fairly conclusively that the three genera into which the flying phalangers are divided by zoologists have been evolved independently of one another from as many non-volant forms. For instance, the great flying phalanger (*Petauroides*), measuring upwards of twenty inches to the root of the tail, is so closely allied to the climbing, crescent-toothed phalanger (*Pseudochirus*) that there can be no reasonable doubt of its having originated from that genus. On the other hand, the smaller squirrel flying phalanger and its allies of the genus *Petaurus* are equally closely related to another non-volant genus known as *Gymnobelideus*. Finally, the tiny little creature known as the pigmy flying phalanger (*Acrobates*), which is not so large as a good-sized mouse, resembles the little pen-tailed phalanger (*Distæcurus*) of New Guinea in having the hairs of the tail arranged in rows on the two sides after the manner of the vanes on a feather; and it may accordingly be inferred that the flying type has been evolved from the one which can only climb.

We have here, therefore, not only the parallelism of the parachute of the flying phalangers to that of the flying squirrels, but likewise three independent instances of parallelism in development among the flying phalangers themselves. We must further call the reader's especial attention to the great difference in bodily size between the great and the pigmy flying phalanger, since this difference is precisely paralleled among the African flying squirrels.

Leaving the phalangers, we pass on to the flying squirrels preparatory to the consideration of the species forming the special subject of the present article. As we have said, all the flying squirrels in the zoological (but not in the popular sense of the term) belong to the rodent order, the distinctive characteristics of which have been pointed out in an article recently published in this journal, under the title of "The Home of the Rodents." It must not, however, be supposed that all flying squirrels belong to a single genus, or even to a single family. As a matter of fact, they may be assigned to two distinct families. What we may call the northern or typical flying squirrels range over a part of Europe, Asia, and North America, and belong to the great family of *Sciuridæ*, which likewise includes ordinary squirrels as well as marmots, chipmunks, or ground-squirrels, prairie-marmots, etc. In all these forms the parachute is supported by a rod of cartilage projecting like a yard-arm from the outer side of the wrist, and there is another expansion of skin connecting the fore limbs with the neck, while there may be a third between the hind-legs and the root of the tail. The whole of these flying squirrels are characterized by the complex structure of their molar teeth; and as their skulls differ considerably from those of other members of the family, they must be regarded as constituting a sub-family group by themselves. Flying squirrels of this group, as we learn from palæontology, have existed since a comparatively early epoch in the Tertiary period, and we are consequently unable to affiliate them with any of the genera of ordinary squirrels; it is, indeed, quite likely that they have originated from a totally extinct genus or genera. Hence, it is impossible to say whether the three genera into which they are divided have all taken origin from one non-volant form, or whether, as in the case of the flying phalangers, the power of flight has been separately evolved in each of the three generic groups.

Of the three genera in question, the one known as *Sciuropterus* includes the lesser flying squirrels, all of which have the crowns of their molar teeth comparatively low, and the parachute of moderate width, and not including any portion of the tail. Having one representative in North America, and a second in north-eastern Europe and Siberia, the lesser flying squirrels are mainly characteristic of India and the Malayan countries. While some of the larger kinds measure as much as twelve inches from the nose to the root of the tail, in the pigmy flying squirrel of Cochin China and Arakan the length of the

* We purposely omit mention of the flying lemur (*Galeopithuus*), which may perhaps also at times be called a flying squirrel.

† Republished in "Life and Rock," by the present writer.

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head and body scarcely exceeds five inches. These squirrels collect in numbers in hollow trees, where they remain in slumber during the daytime, to issue forth at night for the purpose of feeding. Climbing to a coign of vantage on some tree, they take their flying leaps to the bough or trunk of another at a lower level, not unfrequently covering a distance of some thirty or forty yards. The length of the leap is, however, still greater among the members of the next genus, reaching from sixty to nearly eighty yards.

The larger flying squirrels (*Pteromys*) form an exclusively Asiatic group, represented by some ten species, and extending from the Malayan region as far north as eastern Tibet. In addition to their superior dimensions, these flying squirrels are distinguished from the preceding group by the greater width of the parachute along the sides of the body, and the enclosure of the base of the tail in the portion connecting the two hind-legs. The tail itself is, moreover, completely cylindrical, instead of slightly compressed; and the molar teeth have rather taller and more complex crowns than in the lesser flying squirrels. In some of the larger species the head and body may measure as much as eighteen inches in length, while the tail may reach to twenty-four or twenty-five inches.

The last member of the family is the woolly flying squirrel (*Eupetaurus*)—a magnificent species from the neighbourhood of Gilgit, distinguished by the very tall molar teeth, which have flat instead of ridged masticating surfaces. It may be mentioned that the first skin of this species brought to England was the property of the present writer, who did not recognize its scientific interest until the arrival of a living example. From having been used as a perambulator-rug, it now occupies a position in the British Museum as one of the type specimens of the species.

Although, as already mentioned, we are unable to trace the three genera of typical flying squirrels to as many ancestral non-volant forms, yet it will be seen that these occupy a position in the family *Sciuridæ* precisely similar to that held by the flying phalangers in the *Phalangeridæ*. Whereas, however, we have a flying phalanger of dimensions not exceeding a mouse, no member of the typical flying squirrels has such extremely diminutive proportions.

In spite of the circumstance that ordinary climbing squirrels are met with abundantly in Africa, it is remarkable that the typical flying squirrels are replaced by a group so different from the latter that they are regarded by zoologists as constituting a family by themselves—the *Anomaluridæ*. With the exception of the flying lemurs, these are the only mammals provided with a parachute which constitute a family by themselves; and, so far as we are aware, no suggestions have hitherto been offered as to the family of rodents from which they have originated. These African flying squirrels, as they may be collectively called, differ in several important structural features from their Asiatic allies. In the first place, as is well shown in the accompanying illustration, the parachute is supported in front by a rod of cartilage projecting from the elbow, instead of from the wrist; and an additional peculiarity is to be found in the presence of a row of overlapping horny scales on the under surface of the root of the tail, which are believed to be of assistance in climbing, and give the name to the family. Certain structural peculiarities connected with the skull need not be mentioned here.

Hitherto the family has been known only by the short-tailed African flying squirrels constituting the genus *Anomalurus;* most of the species inhabiting West Africa, although one is found in Equatoria, and a second on the east coast near Zanzibar. The smallest is the equatorial species (*A. pusillus*), the so-called pigmy flying squirrel, in which the length of the head and body is eleven inches, and that of the tail just over five inches.

It is but a few years ago that the last-named species was first brought to the notice of science, and with its description most zoologists probably thought that we had exhausted all the interesting representatives of the family, and that nearly the last word had been said about African flying squirrels.

Quite recently there has, however, been discovered in the Cameroons district of Western Africa an entirely new and most interesting representative of the family, constituting a distinct genus (*Idiurus*), and being by far the smallest of all the known flying squirrels. Of this little creature, which may be known by the name of the long-tailed flying squirrel, we are enabled, by the courtesy of its describer (Dr. Matschie, of the Zoological Museum, Berlin) to give a lifelike figure—the first ever published in this country. This little animal is not larger than a small house-mouse, the length of the head and body being only just over two and a half inches, and that of the tail four inches. Agreeing with the ordinary African flying squirrels in the general form and mode of support of the parachute, as well as in the presence of rows of scales on the under surface of the tail, the new species is at once distinguished by the short knob-like nose, and the thinly-haired tail, terminating in a pencil of hairs, and being nearly double the length of the head and body, instead of considerably shorter. In place of being uniformly and thickly covered with fur, the tail is short-haired on its upper surface, with three longitudinal rows of elongated sparse hairs, while beneath it is naked, with three rows of scales near the base. An important difference is also to be found in the structure of the fore-foot, in which the thumb is reduced to a mere knob-like rudiment, while in the hind-foot the first toe is much smaller than the other four, which are of approximately equal length. There are likewise structural differences in the skull, into the consideration of which it will be unnecessary to enter on this occasion.

In colour, the fur of the back and upper surface of the parachute is pale whitish-brown, the hairs being blackish-grey at the base; while on the under surface the general hue is a mixture of yellowish and dark grey, with a tinge of silver-grey on the parachute.

At present known only by the single example represented in our illustration, the long-tailed flying squirrel has precisely the same relation in point of size to the largest members of the family as is presented by the pigmy flying phalanger to the great flying phalangers of Australia, and thereby shows us another curious instance of parallelism in development. Of course, nothing is known as to the habits of the new African animal, and comparatively little of those of the pigmy flying phalanger. The latter creature is, however, stated to be very active in leaping from bough to bough of the trees it frequents; and it may be presumed that, in the case of both animals, the flying leaps merely extend from one bough to another, and do not enable the creatures to pass from tree to tree after the manner of the larger flying phalangers and squirrels.

As it is only quite recently that anything has been recorded regarding the habits of the larger members of the family, we may conclude with an extract from a note published by Mr. W. H. Adams in the *Proceedings of the Zoological Society*, concerning Pel's flying squirrel (*Anomalurus peli*) from West Africa. The writer there states that these squirrels "come out of their holes in the trees some hours after sunset, returning long before day-break. They are only to be seen on bright moonlight

THE LONG-TAILED WEST AFRICAN FLYING SQUIRREL.

From the unique Specimen in the Berlin Museum from the Cameroons District. Natural size.

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nights, and, in fact, the natives say they do not come out at all in stormy weather or on very dark nights. They live on berries and fruits, being specially fond of the palm oil-nut, which they take to their nests to peel and eat. They pass from tree to tree with great rapidity, usually choosing to jump from a higher branch to a lower one, and then climbing up the tree to make a fresh start. The temperature on the hills varies considerably. During the time I was there—the rainy season, from the middle of April to the middle of June—it was never very hot, one night the thermometer going down to 44° on the ground. Of course, in the dry season it is much hotter, but the natives say these animals are much more plentiful in the rains, and that the rainier the season the more they see. They litter twice a year, once about September, the young remaining in the nest for about nine weeks, during which they are fed by the old ones on such food as shoots and kernels; they do not attempt to jump till the end of that period, extending the length of their jumps with their growth. I do not know the other time of breeding, or whether they have a regular season. The hunters told me that two or three were usually born at one birth, and never more than four."

Within the last few years an extraordinary number of new mammals have been discovered in Africa, some of the best known and most generally interesting being several large antelopes from Somaliland. To the naturalist, however, a tiny little creature like the one under consideration, which represents a totally new type, is of far more interest than any antelope, whether the latter indicate a new genus or merely a new species. In Eastern Africa German and English zoologists and collectors are rivalling one another in the zeal with which new or rare forms are brought to light, but on the West Coast our German cousins seem to be having it all their own way. Although we should be the last to envy them the discovery of this latest addition to the mammalian fauna of West Africa, we cannot help expressing a hope that our own countrymen will not allow themselves to be outstripped in the race of discovery and collecting.

AUTOMATIC STABILITY IN AËRIAL VESSELS.

By THOMAS MOY.

THE importance of securing longitudinal stability—which means travelling on an even keel—does not readily suggest itself to those who have not studied this problem. To render the subject familiar: suppose a wagonette full of people to be travelling on an ordinary road, and the hind wheels to suddenly collapse, the passengers would slide downwards to the hinder part, one upon another. The same result would accrue if the vehicle came to a *soft place* in the road. Or suppose a river steamer suddenly went down by the head, and the stern rose up out of the water. In each case longitudinal stability would be lost. Fortunately, these are very unlikely occurrences on land and water; but in the air, and especially with elongated gas bags or aërostats, such uncomfortable "tiltings" frequently happen. It therefore becomes very important that the man at the helm of an aërial vessel should be entirely relieved of anxiety as to its horizontal position, and be enabled to concentrate his attention upon the course to be steered, with as much confidence as if he steered an ordinary river steamer.

Turning a carriage to the right or left upon an ordinary road, or steering a vessel to starboard or port on water, is such a very simple operation, that one is apt to overlook the fact that, in submarine and aërial navigation, the main support is wanting; the road or the water level is not there, and their absence *must* be provided for. It is an absolute necessity that such vessels should be capable of automatically assuming and maintaining the predetermined position, whether perfectly horizontal or slightly inclined. This cannot be carried out by hand. No steersman in charge of the tiller of a horizontal rudder or tail could keep a vessel in the desired position. High speed is most essential to the accomplishment of mechanical flight, and no regular high speed can be secured if the vessel and its carefully arranged planes are continually varying their angle relatively to the course to be travelled.

Recognizing the importance of these facts, I invented and patented plans for securing automatic horizontal stability, in the year 1891, the patent being No. 14,742 of that year. Two methods of carrying out the invention are shown in the specification, and I now propose to describe and explain the simpler of the two methods.

A great many patents have been filed in which the ordinary pendulum has been described, as applied to this purpose. But it will readily be understood that, with a vessel going at a high speed, the power of the mere

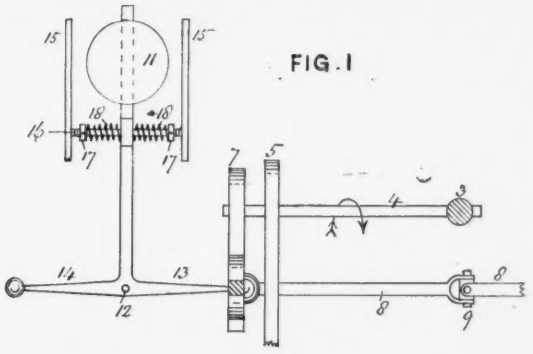


FIG. 1

hanging pendulum is very weak, and it would require a very great departure of the vessel from its true course to bring the power of the pendulum to bear upon the horizontal rudder. This difficulty I overcame—first, by using an *inverted* pendulum, with limited motion; and secondly, by using the position of the pendulum in applying an *independent force* to the correction of any departure from the desired position of the vessel, relatively to its course.

Referring to Fig. 1, 8 is a transverse horizontal shaft, projecting outwards on each side of the stern portion of the vessel, to port and starboard, the outer ends being fitted with horizontal planes for steering. 4 is the tiller, the outer end passing through the vertical guide 5, and entering the slot 6 in the rack 7, as also shown in Fig. 2. In the position shown, the tiller and the steering planes or rudders are supposed to be in a perfectly horizontal position. 8 is a shaft, formed in two parts, jointed at 9, and fitted with a pinion at 10. The pinion is bored out to receive a ball, fitted to the end of the arm 13. The shaft 8 is kept constantly rotating in one direction by any means, such as clockwork, or by a connection with the necessary machinery carried on board, or by a treadle worked by the foot; very little power being required to turn the shaft.

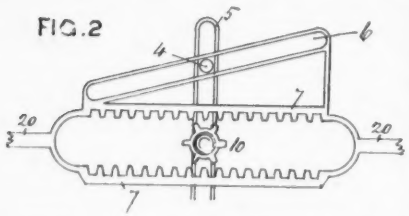
The rack 7 is capable of sliding horizontally in guides, the arms 20 being extended for that purpose; and the pinion 10 and tiller 4 are guided vertically in the guide 5.

The inverted pendulum is pivoted at 12. The arms 13

and 14 balance each other, each having a ball at its outer end. The bars 15 limit the play of the pendulum to (say) half an inch in each direction. But even this limited play of the pendulum may be further reduced by means of electric contact appliances. 16 is a screw-threaded rod, fixed to the bars 15, and passing through a slot in the pendulum rod. 17, 17, are two nuts for regulating two light springs, 18, which keep the pendulum in a vertical position only when the vessel is truly horizontal, the springs immediately giving way when the vessel departs from it.

Supposing that the vessel is travelling from left to right on an even keel, and the shaft 8 is turning in the direction of the bent arrow; the pinion 10 rotates freely between the teeth of the rack, and the rack remains stationary.

FIG. 2



Now suppose the head of the vessel rises two or three degrees, the pendulum immediately falls against the after bar 15, raises the pinion 10, and thereby drives the rack 7 from left to right. This operation lowers the tiller 4, and, with it, the steering planes. The effect of this will be to slightly raise the stern and restore the vessel to the horizontal position.

In order to stop the vessel gradually, and bring it gently down to *terra firma*, you have only to push the pendulum forward by hand, when the rack 7 will be driven from right to left by the pinion, the tiller and steering planes will be inclined upwards, thus bringing the stern downwards. The increased angle of inclination at once reduces the vessel's speed, and it approaches the ground slowly and lands safely.

In case of an accidental stoppage of the rotating shaft 8, the pendulum may be fixed, and the rack may be operated by hand, by means of a lever attached to one of the guide bars 20; or the shaft 8 may be turned by manual power.

The mechanical details may be varied to a very great extent.

Note.—Since the above communication was forwarded to Knowledge, I have read Mr. Maxim's letter in the January number. Mr. Maxim has credited me with a number of theories which I never entertained in my life, and, therefore, they need no reply. My illustration of a boat with a rope attached to a fixed object, or to a floating anchor, has been conjured by Mr. Maxim, by a process best known to himself, into a *something* which he multiplies by 13·1! Then Mr. Maxim (after misquoting what I said about Henson's machine) says: "I know nothing about Henson's machine except what I have heard." Henson's patent is dated 29th September, 1842, No. 9478, and is well worth studying. It anticipates all the essential features of Maxim's machine.

My article is unanswered and unanswerable as to the loss by slip, and the entire neglect of this mode of propulsion by millions of aëronauts, from the tiny house-fly to the Australian crane, all witness to the correctness of my article, and I have one more witness in Mr. Maxim himself. In his paper read at the Society of Arts meeting on the 28th November, 1894, he says (page 35 of the report): "The slip, while running at forty miles an hour, is almost exactly eighteen miles an hour." So he owns to forty-five per cent. loss by slip.—T. M.

THE HESSIAN FLY.

By E. A. Butler, B.A., B.Sc.

ABOUT eight years ago, some excitement and consternation were produced by the announcement that the destructive "Hessian fly" had been discovered in England. When, therefore, this discovery was made, it seemed as though we might look for a most noxious and troublesome, and possibly permanent, addition to that part of the insect fauna of the British Islands by which so much of the agriculturist's toil is neutralized. But whatever fears might have been entertained on this score, they have not yet been realized to any serious extent, and although it is quite true that the Hessian fly is to be regarded as fairly included in the British fauna, yet we do not seem to be at present much the worse for the fact. The area of the distribution of this pest is a wide one, for it has been met with throughout the greater part of the eastern districts of both England and Scotland, especially near the sea-coast. It has occurred in other parts as well—*e.g.*, Mr. F. Enock reports having found large numbers in barley and wheat fields near Stroud, in Gloucestershire; but the eastern counties have been hitherto its head-quarters. Since its first appearance in 1886, the damage done by it in Great Britain has been estimated at a loss of from one to twelve bushels of grain per acre.

The Hessian fly may be taken as another and most striking illustration of the principle we have alluded to on other occasions, that the worst pests, so far from being conspicuous and easily recognizable species, are usually obscure and often very minute. The Hessian fly is, in fact, an insect of such insignificant appearance that none but a trained entomologist would be likely to suspect, on seeing it, that it was capable of becoming a serious plague. It is merely a minute two-winged fly, belonging to the family of gall-gnats, some species of which we described in our articles on "Galls and their Occupants." It is a fragile insect, not more than one-sixth of an inch in length of body, and its fully-expanded wings stretch only about twice that distance. It is difficult to realize that a creature so minute and so delicate can possibly be the author of any serious amount of damage. And yet, that it is one of the most formidable foes the growers of cereal crops have to encounter is, unfortunately, only too true. The scene of its greatest destructiveness has hitherto been America, it having spread from west to east and from north to south over the greater part of the United States.

The family to which the Hessian fly belongs is called *Cecidomyidæ*, and its own name, *Cecidomyia destructor*, very significantly proclaims its evil reputation. It is destructive to both wheat and barley, but does not seem to attack oats. The damage done is of an indirect nature; the larva absorbs the juices of the plant from a point near the base of the stem, just above a joint. In consequence of this cutting off of supplies from the upper part of the plant, the stalk becomes weak, and when the ear is developed, also in a dwarfed condition, the weakened stem can no longer support the weight of the ear, and bends over at a spot just above the joint where the insect is situated. The ear is thus laid prostrate, just as if it had been blown over by the wind, and as it lies on the ground, it not only becomes spoilt with damp and dirt, but also falls an easy prey to field-mice.

There can be little doubt that this insect was in the country at least some few years before it was discovered, though very different views are held as to the exact date

of its first arrival. The Hessian fly is so called because of a tradition that it was introduced into America by the troops from Hesse, who were sent over to assist the British forces in the year 1776, in the war of American independence. The idea was that the insects were unconsciously brought over, in their immature condition, amongst the straw used by the troops. The Hessian troops conducted operations in Long Island, and it was in this spot, and immediately after this time, that the fly is said to have appeared in great numbers. However this may be, it did not attract general notice in Europe till long after that date, for, according to Mr. Inchbald, its first record for the Continent is its occurrence in Minorca in 1834.

The fly (Fig. 1) is gnat-like in shape, with blackish head and thorax, and pinkish abdomen, variegated with black spots. The wings, a single pair, are dark, except at the base, where they are pink, and clothed throughout with black hairs. Behind them are a pair of minute pink knobbed stalks, representing the usual "balancers" of a dipterous insect. The antennæ are composed of seventeen joints, and like those of gnats in general, are beset with circlets of hairs. The legs, which are comparatively long and thin, are pale, with black hairs. The wing has very few nervures, a short one near the front edge, then one running longitudinally right across the wing, and, lastly, one nearer the inner margin, forked at the tip. The female insect is about one-third larger than the male, and also darker in colour. It is a retiring insect, and as becomes so destructive a creature, does not court observation, but likes to retreat into the privacy and shelter of leaves or holes in the ground, resting on the soil, where its dark colour prevents it from being easily seen. The males are more open in habits. The flies may be found twice in the year, in spring and autumn; the spring specimens being hybernated ones of the year before, and the autumn brood the progeny of these, which have passed through their initial stages during the summer months.

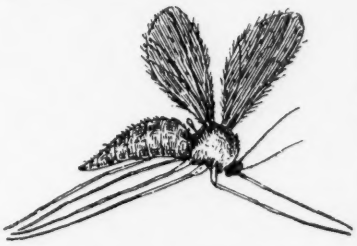


Fig. 1.—Hessian Fly (*Cecidomyia destructor*). (After Ormerod.)

As soon as the female fly has mated, she at once commences the work of laying her eggs. According to Mr. F. Enock, who has carefully worked out the life-history of this pest, as recorded in the *Transactions of the Entomological Society*, there will be from one hundred to one hundred and fifty of these, and as they have to be distributed over particular leaves of suitably selected plants, the business of getting them all properly placed is a somewhat exhausting one, and not unfrequently ends in damage to the mother, to the extent even of the loss of some of her legs. Most of the eggs are laid on the youngest, *i.e.*, the last developed leaves of young plants, and on the inner side of the leaf, in the grooves between the veins, a small number being placed on each leaf, and these not all in one spot, but in small clusters or sometimes singly. They are usually laid, moreover, in such a position that the larva's head, as soon as it hatches, will point towards the base of the leaf, the object of the arrangement being apparently to give the young larva the least amount of exertion in reaching its final resting-place on the stem at the base of the leaf. Of course the eggs are exceedingly minute. They are of a yellowish or reddish colour at first, but become darker as the contained larva matures.

The larva (Fig. 2, A) is a footless maggot, with fourteen segments to its body, pale and transparent at first, but afterwards becoming of a chestnut-brown colour, and finally attaining a length of about the eighth of an inch. When hatched, it has a toilsome journey before it; it must travel, by the workings of its muscles, over a distance of some two or three inches down the leaf, from the spot where its mother placed it, till it gets between the ensheathing part of the leaf and the stem it clasps. Some four hours will be consumed in this arduous journey, and at the end of this time it turns round so that its mouth faces the stem instead of the leaf, as has hitherto been the case, but it still remains with its head downwards. As soon as it reaches this position, concealed between the leaf and the stem, its journeys are over; it has arrived at the spot where it is to spend the rest of its life till it becomes a perfect fly. It therefore at once sets to work feeding; attaching its mouth to the stem, it sucks out the juices of the plant, and this it continues to do till its feeding life is over. The consequences of the attack are, after a time, recognizable in the bent and trailing stem, which falls over just above the position of the larva (Fig. 3).

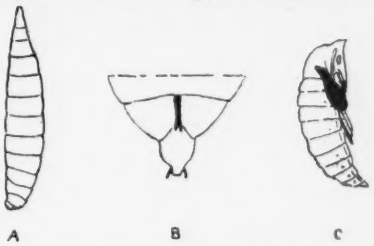


Fig. 2.—A. Feeding larva of Hessian Fly (magnified 8 diameters); B. Head of ditto, with anchor process (magnified 36 diameters); C. Pupa of Hessian Fly (magnified 8 diameters). (After Enock.)

Now comes the strangest part of the story. The creature, it will be remembered, is a dipterous insect, and the maggot-like larvæ of a large proportion of this order do not cast the last larval skin, but become a pupa *within* the old skin, which hardens and darkens into a neat barrel-shaped form. This barrel-like body obviously is not the true equivalent of the chrysalis of an ordinary insect; the genuine chrysalis is to be sought for inside, and the old larval skin serves the purpose of a cocoon, protecting the enclosed soft-bodied insect from whatever agencies might be disastrous to it. A pupa thus enclosed is said to be coarctate, and the whole object, skin and all, is often called a puparium, to distinguish it from a true pupa. Thus, what seems to be simply a chrysalis is in reality that and something more. Now, in the case of the Hessian fly, a further complication is introduced. When the larva has reached its full size, it ceases feeding, and its skin hardens and darkens, and separates from the enclosed being as usual; thus far there is nothing remarkable. The enclosed insect in this case, however, is not a pupa, but still a larva—a fasting larva, it is true, but nevertheless a larva in form, and destined to undergo further changes before the pupa stage is reached. It should, therefore, be called, as Prof. Riley has suggested, not a coarctate pupa, but rather a coarctate larva; the puparium is not the *last* skin of the larva, but the last but one. The outer skin is now of a dark chestnut-brown, and this stage is often spoken of as the "flax-seed" stage, from the resemblance of the coarctate creature in shape and colour to a flax-seed. In this same condition, so far as external appearance is concerned, the insect will remain for at least five or six weeks, and if it belong to the autumn brood, the condition will be prolonged throughout the winter.

But meanwhile considerable changes are taking place in the interior of the "flax-seed," and to understand these we must just consider for a moment the position of the larva, and the difficulties that lie in the way of its emergence into the open air, when it shall have reached its perfect condition. In the first place, it will be remembered that the larva is jammed in between the stem and the sheath at the base of the leaf; further, it is placed with its head downwards; and yet again, its back is turned outward, while its ventral surface faces the stem. Each of these arrangements, admirable enough for the creature's needs while it was a feeding larva, is the exact opposite of what would be necessary to secure for the perfect fly an easy exit. It would need to be nearer the open, with its head upwards and facing outwards, if it were to be at all suitably placed for easily making its way into the open air; for any advance from its present position would only take it further from the light, even if it had the ability, which it has not, of piercing the hard wall of the stem. A complete revolution has, therefore, to take place, and the way in which this is done is one of the most marvellous features in the life-history of this curious insect.

If the "flax-seed" be opened, the larva within is seen to have a curious little appendage near the mouth on the under side, shaped like a rod forked at one end (Fig. 2, B), and capable of being moved about at the plain end as upon a pivot. This curious object has been called the "anchor process," or "breast-bone," and its use was for a long time problematical. To Mr. F. Enock belongs the credit of discovering the use to which it is put, and a very strange use it is. We have seen that the larva needs to completely reverse its position if it is to stand any chance of escaping from its imprisonment, and it uses the "anchor process" in order to do it. By pressing the forked end of this, time after time, against the wall of the so-called puparium, or larva-case, and using it as a lever or prop, the creature is able, by suitable muscular effort, to work itself gradually round inside the narrow case, bending itself double at the bottom of it, and finally turning a complete somersault, so that its head is at the top of the case and faces outwards. Its position is thus greatly improved, though, of course, it is still enclosed within the "flax-seed," which has remained as it was, while its inmate has turned upside down, or rather, right side up; it is, moreover, still jammed in between the leaf and the stem (Fig. 3); and further, it is still a larva, and a good deal has yet to be done before it becomes a Hessian fly.

Fig. 3–Vertical section through bent barley stem, showing "flax-seed" in position (magnified 5 diameters). (After Enock.)

After a time, the larva, or more correctly the coarctate larva, as it lies within the hard, dry skin of the so-called puparium, sheds its skin and appears as a pupa, still, of course, enclosed within the "flax-seed." This pupa is shorter than the larva, and soon shows the outline of legs, wings, head, eyes, &c., in its upper part (Fig. 2, C); it has, moreover, a brown projection something like a parrot's beak near the position previously occupied by the "anchor process." The pupa is at first white, but gradually darkens in colour till it is mature. The insect does not remain more than about twelve days in this state. At the end of that time, it bursts through at the upper end of the "flax-seed," and works its way up between the leaf and stalk, leaving its old shell in the position it has always occupied. It is still a pupa, and another moult has yet to take place before its course is ended. But this final change cannot be made in the narrow quarters between the leaf-sheath and the stem, or the delicate little fly would be imprisoned and unable to escape. The chrysalis itself, therefore, must work its way through the leaf, and it uses its beak to do this. By means of the hard point it cuts a slit in the leaf, just large enough to admit of its pushing through its fore part, which therefore projects into the outer air. The pupa skin now splits along the back near the head, and the fly gradually works its way out of the opening, the hinder part of the pupa-case being meanwhile tightly nipped by the leaf, and held in position so as to give purchase to the struggling fly.

From the above description it will be seen that the fly, as it struggles out of its case, has its face turned towards the open air, and its back towards the stem, where alone support can be found for a weak and struggling insect; and the question naturally arises, how does it manage to complete its extrication without falling over? for, through the softness of its wings, it is not prepared to take flight immediately on becoming free from the pupa-case. Mr. Enock has shown how this difficulty is met. In a specimen that he watched extricating itself, he points out how it first released the head, thorax, antennæ, and part of the abdomen; then followed one wing, then portions of the legs, then the other wing, and then the first pair of legs became quite free. Now it was projecting considerably from the pupa-case, with only the last two pairs of legs still left in their investing skin to hold it upright, and it seemed to be on the point of toppling over; but, continues Mr. Enock, "just when the second pair of legs were quite free, it swung them about until one caught hold of the stem, towards which the fly immediately drew itself until it had a firm hold, when it quickly withdrew the remaining pair of legs, becoming quite free and walking along on the under-side of the bent straw; here it hung attached by its first and second pairs of legs, with the abdomen perpendicular, and the claspers on the tail in the same position; the stick-like wings were flapped together over its back a number of times, and in a quarter of an hour were fully expanded, and then crossed in position; the anal claspers turned up over the back, the tips bent downwards, and at 8.30 p.m., or exactly an hour and a quarter after the straw was split, the fly made its first flight." Needless to say, all these observations had to be made with the assistance of a lens.

The Hessian fly being such a formidable pest, it becomes a matter of the utmost importance to determine in what way its ravages may best be checked. In the case of this creature, as in that of most other insect pests, there can be little doubt that the most efficacious remedy is that which Nature herself provides, in the form of parasites, which, feeding upon the body of the larva, prevent its reaching the perfect state, and therefore cut off all chance of its being followed by a line of descendants. Several of these parasites are known. They are all minute kinds of hymenopterous insects, belonging chiefly to the family called *Chalcididæ*, near allies of the ichneumon flies. They are chiefly of a shining blackish colour, with a greenish tinge.

As the result of two years' work, Mr. Enock obtained a total of four thousand four hundred and fifty-one straws infested with the Hessian fly, and bred from these seven hundred and fifty-two flies and nine hundred and nine parasites. As the number of parasites in general corresponds with the number of larvæ destroyed, it will be seen from

the above instance that nearly sixty per cent. of the larvæ were destroyed by parasites. It is clear, therefore, that to rid ourselves of the pest the parasites should be encouraged in every possible way.

GOLD IN THE BRITISH ISLES.

By ERNEST A. SMITH, Assoc. R.S.M., F.C.S.

THE existence of gold in various parts of our islands has been a subject of remark from the time of the invasion of the Romans. That the Britons collected the precious metal from the tin streams of Cornwall and Devon appears certain, and although there is no reliable information of any kind prior to the Roman occupation, yet by the discovery of gold ornaments at various times in very ancient graves it is rendered more and more probable that gold was found at a very early period in parts of the United Kingdom. The Romans were incited to the conquest of Britain by the reported wealth of its inhabitants in gold, tin, and other metals; and Cæsar, in his Commentaries, says that one reason of his invading the Britons was because they assisted the Gauls with their treasures. On their first landing in Britain, the Romans found the inhabitants in possession of gold and gold coin. Tradition informs us that Cymbolene, Prince of the Trinobantes, worked a gold mine, and he is stated to have coined gold money instead of rings; it having been the usual custom to coin such rings as are found in the bogs of Ireland. The Welsh Triads celebrate Cas-wallan, Manawydan, and Llew Llawgyfes, as three chiefs distinguished by the possession of golden cars. That the Romans worked the ancient gold mine of Gogofau or Ogafau, near Llan-Pumpsant, in Carmarthenshire, about ten miles west of Llandovery, has been clearly proved by the investigations of the late Sir Warington Smyth. That it was a Roman station is indicated by the remains of a bath, pottery, and ornaments found on the spot; several gold ornaments and a very beautiful wrought gold necklace were also found.

Small quantities of gold have been found in Cornwall from the earliest time, particularly in the tin streams. Carew* intimates that the "tinners do also find little hopps of gold amongst their ore, which they keep in quills and sell to the goldsmiths, oftentimes with very little better gain than Glaucus' exchange."

In the "Bailiff of Blackmore," written by one Mr. Beare, in Queen Elizabeth's time, we have an account of "a gentleman that, at a wash of tin at Castle Park, by Lostwithiel, took out of the heap of tin certain glorious *corns* (which they call *rux*) which he affirmed to be pure gold, and at the same time showed a gold ring made of certain gold hopps, which he had gathered among the tin corns at a wash in a stream works."

He tells us also that Mr. William Glynn, of Glynn, had a gold seal ring made of gold hopps found in the river Fowey.

The largest nugget of English gold which has been found, or at all events of which the history is well authenticated, weighed under three ounces—a lump barely meriting a loftier rank than that of a "specimen," when compared with the large nuggets unearthed in Australia and California. In the reigns of Edward I. and III. mines were worked at Combmartin, in Devonshire, from which gold was obtained; between 300 and 400 miners, sent for out of Derbyshire, were employed in them, most of the produce going to assist in the wars against France. In the reign of Henry III. a copper mine which was worked in Newlands, Cumberland, is said to have contained veins of gold as well as of silver. Gold has also been found in a large number of the counties of England and Wales, but not in quantities sufficient to pay for working. The Patent Rolls in the Tower record several grants of privilege to search for gold and silver.

The most important gold region of Britain, however, lies in North Wales. Who the Cadmus was that first, on the hills of Merionethshire, exclaimed with Shakespeare's Timon

> "What is here?
> Gold? yellow, glittering, precious gold?"

is uncertain, precedence being claimed for several persons; but the first to notice the existence of something like a complete system of auriferous veins was Mr. Arthur Dean, who communicated his discovery to the British Association at York, in 1844.

In consequence of his statements operations were commenced at Cwmhesian, but the result not being satisfactory, they were finally abandoned.

On the banks of Afon-wen, about a mile above the bridge, are some ruins of buildings, and below them, close to the river, the remains of charcoal ashes and bits of bones, mostly covered with herbage. This place has a very singular and, in conjunction with the gold discoveries, a very significant name, which it has maintained from time immemorial, expressive of gold having been melted or worked there. This name, Merddyn Coch'r aur, signifies "the ruins of red gold." The tradition is that the Romans formerly worked gold there.

The gold district of North Wales appears to be chiefly confined to an area of about 20 square miles, lying on the north of the turnpike road leading from Dolgelly to Barmouth, one of the most beautiful districts in Great Britain. In this region the Cambrian rocks are overlaid by the Silurian, and the general geological features of the country resemble those of other auriferous localities, more especially those of the south-east States of North America, where almost all the indications of the associated rocks and minerals are precisely similar. The strata in which the auriferous lodes occur belong to the junction of the lower and upper Cambrian strata, where the Lingula flags of the latter rest upon the uppermost grits and quartzites of the former group. The Cambrian being one of the oldest rocks in the British Isles, it is particularly interesting to the scientific student, and in no place is it better represented than in the range of mountains in this area.

It is yet possible that with economy and judgment in mining, and with the employment of the best machinery for dressing the ores, some of the mineralized quartz veins in North Wales will pay to work for gold. The gold extracted from the Welsh ores is of a pale yellow colour, owing to the presence of silver, and is usually about 18 to 22 carats fine. The centre-piece presented to the Duke and Duchess of York, on the occasion of their marriage, was made of 18 carat gold and sterling silver obtained from the Welsh mines. It is one of the largest examples of gold and silver work produced in modern times, and its weight exceeds 2¼ cwt. The wedding ring of the Duchess was also made from Welsh gold.

Gold has been found in Scotland to some small extent in strata similar to those just described. It is the general opinion of archæologists that the gold ornaments of the prehistoric ages were made from native metal. The first historic notice of gold occurring in Scotland is the grant of David I. to the Abbey of Dunfermline in 1153 of a tithe of all gold which should accrue to him from Fifeshire.

Gilbert de Moravia is said to have discovered gold in Duri-

* Carew's "Survey of Cornwall, with Notes," 1811.

ness, in Sutherlandshire, in 1245, and in more recent times gold has been found at Helmsdale.

In 1852 there was considerable excitement over the attempts made to resume the working of these long-abandoned deposits. The gold-digging mania lasted about a month, and many coal and iron miners threw up their employment to embark in the alluring lottery of gold-seeking. The origin of the mania was the statement of a convict, a native of Kinnesswood, who wrote from Australia to the friends he had in the Kinross-shire village, that he had often seen gold at home in the lime quarries similar to that which was being dug in Australia. At this particular time the public mind was in a condition of great excitement, produced by the brilliant discoveries in California in 1847, intensified and revived by the no less splendid results of gold-digging in Australia in September, 1851.

The records of the Scottish Parliament contain frequent mention of gold. The mines of Manlockhead, in Nithsdale, were in full working until the defeat at Flodden in 1513, and the death of the king led to the suspension of operations. In the reigns of James IV. and V. of Scotland, vast wealth was procured in the Leadhills, in Lanarkshire, from the gold washed from the mountains; in the reign of the latter, gold to the value of £300,000 sterling is said to have been found. The men of this mining district have occasionally employed their leisure time in searching for the precious metal among the alluvial deposits and mine *débris* of the district. The able-bodied Leadhills miner never, however, gives up his usual labour, at which he earns about fifteen shillings per week, for the more precarious gains to be derived from gold-finding. To gold-seeking he devotes his spare hours, his holiday times, or his periods of sickness or debility, and very frequently his Sundays.

The gold thus collected is mostly to order for cabinet specimens, or for jewellery materials. Many of the wealthiest families in the vicinity have ornaments made of it, and the Empress Eugénie has a necklet manufactured from the gold of her grandfather's country.

The method of collecting the gold at Leadhills with the primitive wooden trough is essentially that employed in the early history of gold diggings. In many places the precious metal may be rendered visible after fifteen or twenty minutes' washing, and frequently small nuggets have been found weighing from 1 to 4 or 5 dwts., but these are often either contained in pieces of loose quartz or have quartz fragments attached to them.

The Albany medal was made in 1524 from gold found in these mines; the Scottish Regalia and the celebrated bonnet-pieces of the reigns of James IV. and V. were also made of native metal.

At the marriage banquet of James V. with Mary of Guise, several cups filled with native gold were presented to the French envoy and his suite, as specimens of the wealth of a country at the apparent barrenness of which they had jeered. From the account books of James V. we learn that miners were sent to Scotland from Lorraine, in 1539, to work the Crawford mines on behalf of the king. They were placed under the charge of a goldsmith, John Mossman, and it appears that between 1538 and 1543, 41¼ oz. of native gold were used in making a crown for the king and 35 oz. for a crown for the queen, 17 oz. for the king's great chain, and a belt for the queen weighing 19½ oz. Beyond this there was a large coinage of gold bonnet-pieces as before stated, and special gold ornaments; all the metal having been obtained from Crawford and other moors.

About 1578 Sir Bevis Bulmer, described as "an ingenious gentleman" who worked the diggings very vigorously, is said to have found two nuggets of pure gold, one weighing 6 oz. and the other more than 5 oz. Bulmer erected a stamping mill and succeeded in getting much "mealy gold." He worked at several mines in Scotland, but appears to have been most successful in Hinderland Moor, in Ettrick Forest, which gave him large quantities of gold, "the like of it in no other place in Scotland," and he presented to Queen Elizabeth a porringer made of native Scottish gold.

It does not appear that the process of obtaining gold by amalgamating it with quicksilver was in use at this time, so that only the coarser particles could have been obtained, while the quartz veins were scarcely touched at all. Gold must have been found about 1683, as a gold medal, struck to commemorate the coronation of Charles I. in Scotland, bears round the edge, EX AVRO VT IN SCOTIA REPERITVR. From that time until very recently no considerable attempt to find gold has been made in Scotland.

Ireland, now so constantly bewailing its lack of mines, was better favoured in former days than any other portion of the United Kingdom. So well was this known that, at the period when the Norman princes exacted treasure for the use of their French possessions, England was required to furnish 23,730 marcs of silver alone, while Ireland was called upon for 400 marcs each of gold and silver—an enormous quantity in those days. Gold ornaments were more common in Ireland than in other parts of the British Islands, and the abundance of gold ornaments and weapons found in the Emerald Isle clearly show that large quantities of gold must have been obtained at a very early period of its history.

The localities in Ireland which have yielded gold in the largest quantities are Ballinvally, Ballintemple, and Killahurler, all situated in the same valley. At the present day small quantities of gold are bought by the Dublin jewellers from the neighbouring cottagers, who have obtained it from the refuse of the old Government works and the beds of the streams. One nugget found at the Wicklow mines is affirmed to have weighed 22 oz., another 18 oz., and others 9 oz. and 7 oz., and so on to the smallest particles. However, more than forty years ago there was exhibited in the rooms of the Royal Dublin Society one specimen weighing, with the quartz attached, 40 oz.

There are perhaps few countries of the world in which gold is more generally distributed than in the British Isles. It has been found in a large number of districts, and only a few years ago specks of it were detected in a quantity of pebbles taken out of a gravel pit on Tooting Common, in the suburbs of London.

Notice of Book.

History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. Third edition. (A. & C. Black, 1893.) When the first edition of this now well-known work was published, a history of astronomy in its modern developments was greatly needed. The valuable work of Prof. Grant appeared more than forty years ago, and dealt with the science of the *movements* of the heavenly bodies, whilst researches into their *nature* belong entirely to the latter half of the present century. And this new astronomy, which has grown up by the side of the old, lends itself, as the authoress observes, more readily to popular treatment than the former aspect of the science. How well Miss Clerke has performed her task, the appearance of a third edition in less than ten years is a convincing proof. These editions are not simply reissues; each shows a distinct improvement upon its predecessor, besides being thoroughly

brought up to date. The book has grown in size, and by "a process of assimilation rather than of mere accretion," so well has the new matter been incorporated with the old. Well arranged, and written in the authoress's agreeable and lucid style, its wealth of accurate detail neither overpowers nor confuses, and the volume is as fascinating as it is instructive.

The period with which the work deals has been a memorable one in the history of astronomy. Planets and satellites have been added to the solar system, and, through the great improvement in all instruments, astronomers have been able to carry their investigations to a degree of completeness and accuracy formerly undreamed of. The invention of the spectroscope has opened an entirely new field of research, and its far-reaching discoveries are probably only in their infancy. Photography has come to our aid, giving us new views as to the character of the nebulæ, and has disclosed vast regions of space, peopled with countless stars. The science, too, has greatly changed its aspect. Once the study of the few, it has become of the deepest interest to the many; once considered from its very completeness and perfection to be losing in interest, it has disclosed infinite possibilities for the future.

To give any detailed account of a work like the present one is manifestly impossible; we can only briefly touch upon one or two points, and for the rest must refer our readers to the book itself.

The work appropriately opens with a *résumé* of the progress of our knowledge of the sidereal universe, and an account of the discoveries of the elder Herschel, commenced in 1774, and only ending with his life. When he began "to explore with line and plummet the shining zone of the Milky Way," he commenced with the convenient assumptions that stars are equally distributed, and that apparent brightness is an approximate measure of a star's distance. The first assumption led to his adoption of the theory of Thomas Wright, that the Milky Way "is the projection on the sphere of a stratum or disc of stars (our sun occupying a position near the centre), similar in magnitude and distribution to the lucid orbs of the constellations." Herschel was further led to assume that, since his large telescope resolved numerous nebulæ into stars, *all* nebulæ would be resolvable with sufficient optical means.

He soon saw that the assumption of an equal distribution of stars must be given up: the detailed examination of the Milky Way and its numerous associated clusters was sufficient to disprove it; and he described our sun and its companion stars as surrounded by a magnificent collection of innumerable stars, called the Milky Way—thus abandoning the "disc theory" of the universe, which, however, long held its ground in the literature of the science. He was also led to admit as probable that *all* nebulæ were not of a stellar nature; but this question was only finally answered by the spectroscope.

Bessel adopted *the amount of proper motion* as a better criterion of the distance of a star than its brightness. It was impossible to resist the conclusion "that the apparently swiftest moving stars are *on the whole* the nearest to us," and the discovery of the swift movement of the inconspicuous star 61 Cygni showed that the fainter stars may be much nearer than others of greater brightness. The parallax of stars, again, showed no relation between nearness and brightness, Canopus, Arcturus, and Rigel being indefinitely remote, and exceeding our sun perhaps two thousand times in brilliancy, "while many inconspicuous objects, which prove to be in our relative vicinity, must be notably his inferiors." It follows, therefore, that stars are *unequally* distributed, and of *unequal* brightness, and if we consider the spectroscopic evidence we reach still further conclusions:—

"Brilliant suns are swayed from their courses by the attractive power of massive yet faint luminous companions, and suffer eclipse from obscure interpositions. Besides, effective lustre is now known to depend no less upon the qualities of the investing atmosphere than upon the extent and radiative power of the stellar surface. Red stars must be far larger in proportion to the light diffused by them than white or yellow stars. There can be no doubt that our sun would at least double its brightness were the absorption suffered by its rays to be reduced to the Sirian standard; and, on the other hand, that it would lose half its present efficiency as a light source, if the atmosphere partially veiling its splendours were rendered as dense as that of Aldebaran."

The Milky Way can no longer be regarded as "the mere visual effect of an enormously extended stratum of stars, but as an actual aggregation, highly irregular in structure, made up of stellar clouds and groups and nodosities." But we cannot pursue this subject further, except to mention the singular "dark holes and dusky lanes" shown on the photographs by Barnard, Russell, and others, with which the Milky Way is tunnelled and furrowed. These dark spaces, which often appear to be bounded sharply by lines of stars, present a difficult subject for investigation. It seems practically certain that they cannot be casual interspaces between irregularly scattered star masses. Such spaces, with sharply defined edges, do not occur among points scattered at random on a plane, and it is obviously far more improbable that they should exist among stars scattered through space, forming tunnels directed precisely in the line of sight.

Long ago, as has been stated, Sir W. Herschel was led to conclude that all nebulæ could not be wholly stellar, and spectroscopic researches, commenced by Huggins in 1863, have abundantly proved the gaseous nature of many of these objects. Not less important is the evidence of the intimate connection between nebulæ and stars. Dr. and Mrs. Huggins, in 1888, found in the nebula of Orion "four groups of fine bright lines, originating in the continuous light of two of the trapezium stars, but extending some way into the surrounding nebula." And from Dr. Roberts's beautiful photographs of spiral nebula, with stars arranged along the nebulous spirals, we are driven to the same conclusion of intimate association. Indeed, as Miss Clerke observes, in speaking of Dr. Common's magnificent photograph of the nebula in Orion, "photography may be said to have definitely assumed the office of historiographer to the nebulæ," and this method will certainly, in time, set at rest all questions of variability in form or brightness. Thus, putting aside such vexed questions as that of the mysterious "chief nebular line," some certain results have been arrived at with regard to the true status of nebulæ. They can no longer be regarded as remote worlds of stars, and if we "add the evidence of the spectroscope to the effect that a large proportion of these perplexing objects are gaseous, with the intimate relation obviously subsisting between the mode of their scattering and the lie of the Milky Way, it becomes impossible to resist the conclusion that both nebular and stellar systems are parts of a single scheme."

The interesting chapter on solar theories is well fitted to serve as a lesson in modesty, so diverse and conflicting are the various hypotheses, so difficult to harmonize are the observed facts. But amidst the doubt and confusion, some conclusions seem tolerably certain. Thus it seems probable "First, that the sun is mainly a gaseous body; secondly, that its stores of heat are rendered available at

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the surface by means of convection-currents—by the bodily transport, that is to say, of intensely hot matter upwards, and of comparatively cool matter downwards; and thirdly, that the photosphere is a surface of condensation, forming the limit set by the cold of space to this circulating process."

The following chapter, on recent solar eclipses, well sums up the main results of observations, and gives an impartial account of the various theories as to the nature of the corona, none of which seem completely satisfactory. Briefly to sum up the results, we know that the corona is not a "solar atmosphere": it is partly made up of self-luminous gases—chiefly hydrogen, and the unknown substance named coronium giving the green ray 1474; partly of white hot solid or liquid particles shining with continuous light. It is practically certain that its form varies with the ebb and flow of solar activity, and it is certain that it is of the extremest tenuity, as comets pass through it without sensible perturbation. "Not even Mr. Crookes's vacua can give an idea of the rarefaction which this fact implies. Yet the observed luminous effects may not in reality bear witness contradictory of it. One solitary molecule in each cubic inch of space might, in Prof. Young's opinion, produce them; while in the same volume of ordinary air at the sea-level, the molecules number (according to Mr. Johnstone Stoney) twenty thousand trillions!"

The chapter on solar spectroscopy, into which we cannot enter in detail, contains a needed caution against the hasty assumption that a substance does not exist in a sun or star if its distinctive lines are not seen. "It may be situated below the level where absorption occurs, or under a pressure such as to efface lines by continuous lustre; it may be at a temperature so high that it gives out more light than it takes up, and yet its incandescence may be masked by the absorption of other bodies; finally, it may just balance absorption by emission, with the result of complete spectral neutrality."

Impartiality is one of the highest virtues of a historian, and it must be allowed that Miss Clerke has shown this virtue in a high degree. Indeed, if we may permit ourselves to criticize what is on the whole an admirable performance, we should say that she sometimes carries the virtue of impartiality to excess. Here and there she appears unwilling to exercise her judgment in estimating the relative values of conflicting theories. Occasionally, too, her judgment seems to the writer to be somewhat at fault. Thus, in referring to Prof. Holden's valuable monograph on the nebula of Orion, Miss Clerke quotes, as almost an ascertained fact, his conclusion that the brightness of the various parts of the nebula has been and is in a state of continual fluctuation. Now, without in the least wishing to detract from the merit of Holden's excellent work, we think that in view of the materials he had to deal with—consisting exclusively of hand-drawings—the evidence in favour of changes of brightness is really very slight. Anyone who has attempted to delineate such objects will admit that while it is very difficult to attain accuracy in regard to form, it is still more difficult to be true to the relative intensity of the various parts of a complicated structure; and a comparison of the most detailed drawing of the Orion nebula (that of Lord Rosse) with one of the photographs of Dr. Common or Dr. Roberts, will show at once that it is here that the drawing most conspicuously fails. In a matter of such difficulty, therefore, we should prefer to consider the subject of changes of brightness as entirely an open one, and trust for the future to the evidence of photography alone.

In an appendix, Miss Clerke gives a brief chronology of astronomical discoveries from 1774 to 1893, a list, with particulars, of the forty largest telescopes in the world, and one or two other useful tables; and last, but not least, we have a good and copious index, which adds much to the value of the work.—W.H.W.

BOOKS RECEIVED.

Elliptical Orbits; their destructive mechanical characteristics and their possible origin. By Henry Larkin. (T. Fisher Unwin.) 1s.

Pen Pictures and How to Draw them. By Eric Meade. (L. Upcott Gill.) 2s. 6d.

Text-Book of Sound, being Vol. I. of "*The Tutorial Physics.*" By Edmund Catchpool B.Sc. L nd. (University Correspondence College Press Strand, W.C.) 3s. 6d.

Practical Forestry. By A. D. Webster. (W. Rider & Son.) 5s.

A Few Chapters in Astronomy. By Claudius Kennedy, M.A. (Taylor & Francis.)

Animals, their Past and Future. By Rev. G. H. Pember, M.A. (Hodder & Stoughton.) 1s.

Travels with a Sunbeam; or Elements of Astronomy. By Arthur Z. Dade. (W. G. Moore & Co., Birmingham.)

The Journal of the Camera Club for December. (Harrison & Sons, St. Martin's Lane, W.C.) 1s.

The Journal of the British Astronomical Association, Vol. V., No. 2. (Eyre & Spottiswoode.) 1s. 6d.

The Journal and Transactions of the Royal Photographic Society of Great Britain for December 22nd.

Journal of the Photographic Society of India for December. (Thacker, Spink & Co., Calcutta.)

The Review of Reviews for December. (125, Fleet Street, E.C.)

NOTE.—The publishers would be glad to be informed of any books sent in for review during the last few months, and not acknowledged owing to the long illness of Mr. Ranyard.

DARK "LANES" OF THE MILKY WAY.

By E. WALTER MAUNDER, *Hon. Sec., R.A.S.; President, British Astronomical Association; Superintendent of the Physical Department, Royal Observatory, Greenwich.*

THAT the stars generally, and more particularly the stars of the Milky Way, *appear* to show a definite structure in their grouping is undeniable. The question as to whether this appearance of structure has any real significance is by no means so simple. It is impossible to examine a rich field in the Milky Way, or a photograph of such a field, without the eye at once linking neighbouring stars together, and tracing out lines, curves, circles, ovals, and festoons of stars, not to speak of more compact clusters; but the reality of these forms has been often called in question.

It has been pointed out, first of all, that a purely chance arrangement of points and dots gives rise inevitably to precisely similar groupings. Raindrops on a pavement, splashes of ink from a brush, are just as fertile in showing such lines and curves. It is argued, therefore, that no stress whatsoever can be laid upon such forms. They are, so it is said, far more a result of our own mental processes than of stellar distribution, and if of stellar distribution at all, then only one of chance.

It is further urged that though we see the stars as if projected on a plane, we are really looking through an infinite depth of space. Of, say, six stars apparently at equal distances in a straight line—and this would be a very definite and precise formation—one might be at a distance of but twenty light-years, another at twenty times that distance, and the rest irregularly distributed in between. So far, then, from these stars forming a system, we ourselves might positively be nearer to one of them than any one of them was to any other.

A third argument has been that even in the telescope the apparent disc of a star is enormously greater in angular

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NORTH.

EAST. WEST.

SOUTH.

PHOTOGRAPH OF THE MILKY WAY AROUND γ CYGNI.

Taken by Dr. Max Wolf, Heidelberg, with a Voigtlander lens, on the nights of June 29th, 30th, and July 1st, 1894. Total duration of exposure, 9 hours 7 minutes.

Direct Photo Engraving Company, 9, Barnsbury Park, N.

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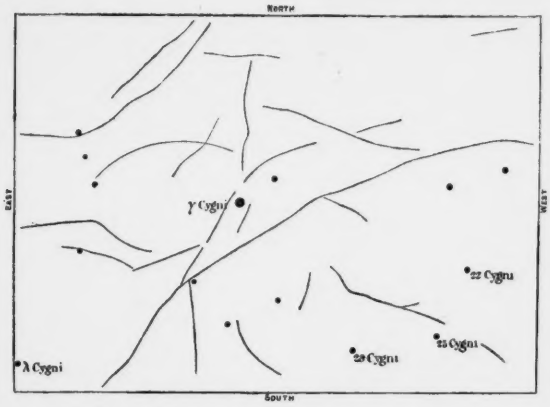
magnitude than the real diameter of the star; whilst its photographic image is still further enlarged to an unreasonable degree. Thus, in the photograph reproduced in our plate (for which we are indebted to the kindness of Dr. Max Wolf, of Heidelberg), the diameters of the stars λ, 22, 25 and 28 Cygni average 5′ of arc each, which, if we ascribe to them the very moderate parallax of 0·1″ of arc, would correspond to three thousand times the radius of the earth's orbit—say, two hundred and eighty thousand millions of miles. In other words, the diameters of their photographic images are not improbably a quarter of a million times as great in angular measurement as the actual diameters of the real stars themselves. A fictitious appearance of connection is thus created, which would instantly vanish if we could produce a picture of the region in which the diameters and distances of the stars were both represented on the same scale.

It cannot be denied that there is a great deal of force in these three objections. They do not, however, apply to a feature—the dark rifts or "lanes"—which photographs of the Milky Way show in abundance. Of these the accompanying plate shows some examples, though by no means of the most striking character that could have been selected.



Sketch Map of Plate, showing direction of Dark "Lanes" in the Milky Way.

This photograph shows the Milky Way in the neighbourhood of γ Cygni, and overlaps the photograph, also taken by Dr. Max Wolf, which was reproduced in KNOWLEDGE for October, 1891. The two photographs, with a third, which appeared in KNOWLEDGE for December, 1891, should be studied together. The star γ Cygni, which is in the centre of the present plate, is easily recognizable in the south-west corner of the plate published in October, 1891. It must, however, be noted that the scale of the two photographs is not precisely the same.

A very cursory inspection of the plate shows that it is intersected by a number of narrow rifts or channels, traceable with equal distinctness over the richer and more nebulous region on the west, and the poorer district on the east.

That these rifts are not mere accidents of this particular photograph can be seen by a comparison with the plate already alluded to as published in October, 1891. The two great lanes in the north-east corner of the present plate are shown with even more distinctness in the south-west corner of the earlier photograph, which was taken with a different telescope, on a different scale, with a different exposure, and on an occasion three years earlier. The longer of the two rifts is traceable on the earlier plate for 10° in a direction which scarcely deviates appreciably from the rectilinear, and ceases to be visible, not because the rift itself has come to an end, but because the photograph does. The chief rift on the present plate is not quite so conspicuous, but may be traced from the south side of the plate, a little to the west of λ Cygni, to a point near a bright star, where it forks off into two directions. Of these the westerly rift passes south of γ Cygni and turns nearly due west, its course being traceable to the edge of the plate. The other branch runs more nearly northward, passes very close to γ Cygni on the east, and then, turning in a direction nearly parallel to the first branch, gradually loses itself.

The courses of these and other principal rifts are roughly indicated in the index map.

The objections brought against the reality of lines and chains of stars do not hold good when applied to these singular rifts. The tendency of the eye, or rather of the mind, to form patterns from disconnected dots has no application to the case of a long narrow strip of sky, practically void of stars. The enlargement of the discs of stars from photographic diffusion would tend to conceal such rifts when they do occur, not to counterfeit them when they do not; and the existence of any other stars in the line of sight, either nearer than the rifts or beyond, would interrupt or conceal them.

There are not a few cases in the plate before us where it appears as if a rift were rendered less obvious by the intervention of a small cluster of stars or, in one instance, of nebulous matter. But the course of the rift is so clearly the same on both sides of the interruption that there can, I think, be little doubt that we have in these cases merely the accident of a few luminous objects in the same apparent direction from us, but wholly unconnected with the rift. We have the right to expect that such would sometimes occur, and their occurrence is therefore no argument against the reality of the rifts.

But what can the rifts or "lanes" themselves be? Seeing that they extend for distances which must be reckoned, not by billions of miles, but by the million billion—for a length of 8° or 10° can hardly involve less—it is impossible to conceive that we have here a case of absorption by streams of dark bodies. It must be borne in mind that many of the rifts must be far longer than they appear to be; for though our position within the circle of the Milky Way will necessarily tend to represent rifts parallel to its main axis as practically of their true proportions, many others must, no doubt, be seen by us as more or less foreshortened. Refer again to the α Cygni plate, of October, 1891, and note how the greatest rift of all rises sharp and dark against the very brightest part of the great nebula on the east of the plate, and following a sinuous course turns up northward in one branch along the east edge of the plate, and in another westward across the centre of the plate just north of α Cygni. The boundaries of the rift in both its branches—and, indeed, also in a third branch which springs from the same point of divergence, and running through a sparser region can be traced south of α Cygni to a junction with the second branch near the west side of the plate—are defined sometimes by nebulous matter, sometimes by stars. And all three are traceable alike in nebulous regions, regions of closely-clustered stars, and where they are thinning off. The reality of the rifts cannot, then, be challenged, for they are independent of the character of their bordering.

If not dark absorbent matter—and I do not see how that idea is tenable in the case of markings so prolonged and so comparatively narrow—what other conclusion can we come to but that the rifts mark regions of real barrenness of stellar and nebulous material? So regarded they become, I think, eloquent of a process of condensation going on in

the Galaxy; a transition from a more homogeneous condition to one of greater agglomeration in certain regions. And this transition is one which is going on, not only with the nebulous matter, but also with the stellar.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

To the Editor of KNOWLEDGE.

DEAR SIR,—The remarks on the spectrum of β Lyræ, made by Father Sidgreaves in the last number of KNOWLEDGE, are of especial interest just now, when the nature of that star is one of the moot points in astrophysics. Nor does there seem to be any good ground for calling in question the validity of his reasoning as regards the possible projection of a partially dark upon a bright line in such a compound spectrum as β Lyræ is reasonably inferred to show. But the line produced in the way he suggests would still be fairly strongly illuminated; only a differential effect could be produced. In β Lyræ, nevertheless, the projected rays seem to be absolutely black. One of them certainly is. Dr. Vogel expressly states that there is a total absence of chemical action along the line enclosed within the brilliant band representing the first of the ultra-violet hydrogen series (H ζ), in which the spectral changes of the star are most characteristically shown. A hint is thrown out that this remarkable circumstance may be a photographic effect due to rapid development; but the fact remains that the stripe is totally dark. Hence there appears no alternative but to conclude that where it crosses the spectrum the gaseous light is entirely cut off. This can only be explained, so far as we can see at present, as a "reversal."

A. M. CLERKE.

THE STRUCTURE OF THE UNIVERSE.

To the Editor of KNOWLEDGE.

SIR,—With regard to the views of Prof. Kapteyn, expounded in your last by Mr. Gore, there are some remarks which occur to me. That the stars which surround the sun are chiefly of the solar type has, I think, been substantially proved, though the precise degree of preponderance has not yet been ascertained. But when it is alleged that at a greater distance this relative preponderance is reversed, and that the Galaxy consists chiefly of Sirian stars, I think we are going entirely beyond the evidence.

According to the best estimate at present available, a Sirian star is probably, on the average, about two magnitudes brighter than a solar star, whose mass and distance is the same. Supposing the stars to be uniformly distributed, the number would increase about fourfold for each magnitude. Hence, if we use the number of Sirian and solar stars of any given magnitude as an index to their proportions throughout the sky, the former would appear to be about sixteen times as numerous as they really are. In point of fact, however, the stars do not increase in number, as the magnitude diminishes, so rapidly as this. The true disproportion would probably be nearer to ten times than sixteen times. But this difference is sufficient to upset our calculations. In comparing the Sirian stars of the sixth magnitude, for instance, with the solar stars of the same magnitude, we are comparing two sets of stars the average distance of one of which is at least double that of the other; and if we compare all the stars of each kind up to and including that magnitude, we are comparing the stars comprised in two spheres, one of which has half the radius of the other.

Let us pass, then, from magnitude to proper motion. Suppose, for instance, that we find a preponderance of Sirian stars among those whose proper motion lies between 0·04″ and 0·07″ annually. Do we know all the stars whose proper motions lie between these limits? Certainly not. We seldom know the proper motions of very faint stars, though the case of a binary star with a faint companion often indicates that there are faint stars whose proper motions are considerable. In fact, we only know the brighter stars whose proper motion lies between the limits in question, and we might naturally expect that the majority of these brighter stars would be Sirians. Statistics based on a particular amount of proper motion are of no value unless we know a large majority of the stars with that proper motion, or at least the stars which we know may be considered as impartial representatives of the class. But as regards stars with small proper motion neither of these conditions is fulfilled. We do not know all the stars which possess the motions in question, and those which we do know are selected on account of their brightness, thus giving an undue advantage to the Sirians.

I think if any one will examine the solar stars down to, say, the fifth magnitude, tabulating their proper motions, and then estimate what the magnitude of a solar star with a proper motion of 0·04″ might be expected to be, he will find an easy explanation of why we know of so few solar stars with this proper motion.

Nor do I think the photographic results attained in the Galaxy conflict with these considerations. Sirian stars are even more superior to solar stars in their photographic power than in their light. If they appear to be multiplied tenfold to the eye, they probably appear to be multiplied fiftyfold in the photograph. But, generally speaking, long exposure brings out more and more stars in the Galaxy without any limit so far as we know at present. What are these stars? Are they Sirian stars situated at greater distances or of smaller mass? Or are they solar stars mixed up with Sirians, but which require much longer exposure in order to impress their images on the plate?

The whole question is evidently one in which superficial appearances may deceive us. The evidence requires not only to be stated but to be carefully weighed, and it is by no means the only instance in which astronomers seem to me to have deduced conclusions from insufficient premises. When we have ascertained the spectra and proper motions of all stars down to the eighth or ninth magnitude, we shall be in a better position to offer an opinion; and it is by no means impossible that the solar stars may be found to retain their relative preponderance as far as our list of proper motions can be regarded as complete. I believe they do so at present.

In conclusion, I wish to make one or two objections to the theory that solar stars develop into Sirians. In the first place the difference in brilliancy is, I think, too great; but, in the second place, the solar stars whose spectra approach nearest to the Sirian type—the Capellans, with the spectra designated E, F, and G in the *Draper Catalogue*—appear to be the least brilliant of solar stars. On the theory of development, therefore, solar stars must diminish in brilliancy as they approach the Sirian type, although the increase in brilliancy is great when they attain it. Indeed, the fact that the spectral types B and F stand at opposite ends of the scale of proper motion seems to me fatal to any theory of development.

Truly yours,

W. H. S. MONCK.

To the Editor of KNOWLEDGE.

DEAR SIR,—M. Deslandres, in his letter on the electric origin of the chromosphere published in the December number of KNOWLEDGE, alludes to my experiments on the radiation of sodium vapour, and mentions as a possible objection to my conclusions the fact that the recipient I used is either attacked by the sodium or is rendered slightly porous when strongly heated, and may allow gases from the Bunsen flame to find their way by diffusion into the sodium vapour, thus setting up chemical reactions whence the D radiation may be derived. He also suggests that ordinary sodium is not in a sufficiently pure condition for the purpose of my inquiry, since it contains hydrogen in some quantity.

I am very glad of the opportunity he has thus afforded me to answer these objections and state more clearly the nature of the evidence on which I rely to prove that the radiation observed is not the result of any kind of chemical action but is simply due to heat.

With regard, then, to the possible effect of leakage or diffusion inwards of gases outside the heated tube, I may point out that as hydrogen diffuses through red-hot iron much faster than oxygen or any other gas capable of reacting with sodium, there will always be a stream of hydrogen molecules flowing outwards when hydrogen or coal gas is the medium employed in which to heat the sodium. This outward current is aided in most of my experiments by maintaining a slight pressure inside the tube above the atmospheric pressure. Thus, if external gases gain access to the sodium at all, it can only be by diffusion through the outward flowing hydrogen.

But, even admitting the possibility of minute traces of such external gases finding an entrance to the tube, the chemical action so produced could under no circumstances be expected to originate the broad D emission line or band actually seen; at the most it would give rise to a fine double D line similar to that of a flame tinted with a salt of sodium, and where the density of the reacting molecules is very small. Furthermore, the bright D band corresponds exactly in width with the absorption band seen when white light is passed through the vapour, indicating that every molecule concerned in the absorption is also concerned in the radiation—that is, every free sodium molecule in the hot part of the tube takes part in the production of the bright D band; and it would be absurd, under the circumstances, to suppose that every molecule was at the same time undergoing chemical change. The only alternative is to suppose that the radiation is the direct result of the heat.

As to the question of the purity of the sodium employed in the experiments the same argument applies, for there must always be a large excess of free sodium molecules over any others existing as impurities. It is true that sodium will absorb two hundred and thirty-seven times its volume of hydrogen at a certain temperature, but the compound so formed is a very feeble one, and is dissociated again at a temperature far below that at which the vapour begins to glow.

With regard to the application of my results to the chromosphere radiation, I will only go so far as to claim to have removed one of the chief obstacles in the way of accepting the "incandescent" theory by showing that gases can be made to emit their characteristic light by heat alone; and I think, therefore, that this theory deserves to be carefully reconsidered by physicists, particularly as it requires fewest assumptions.

The great difficulty to my mind in accepting M. Deslandres' view is that it necessitates the assumption of a continuous discharge of electricity over the entire solar sphere. This seems to imply a shell of matter external to the chromosphere charged in an opposite sense to the photosphere, the difference of potential between photosphere and external shell being in some unknown way maintained constant in spite of the perpetual sort of brush discharge going on.

The analogy drawn by M. Deslandres between the electrical phenomena of the solar and terrestrial atmospheres is a very interesting and suggestive one; but (fortunately, perhaps, for our well-being) the difference of potential between the higher and lower strata of our air does not necessarily imply a constant discharge of electricity over the entire surface of the globe, and there is no phenomenon known on the earth, except possibly the aurora, to complete the analogy, which thus seems to fail in its application to the chromosphere radiation.

J. EVERSHED.

THE PROGRESS OF ASTRONOMICAL PHOTOGRAPHY.

To the Editor of KNOWLEDGE.

DEAR SIR,—I am pleased to have the opportunity, which Miss Agnes M. Clerke's letter in the September number of KNOWLEDGE under the above heading gives me, of frankly admitting the shortcomings of my address, and my regret. But at the beginning of my address, and again near the close, I endeavoured to make its incompleteness known. Thus I said (page 2), "In this brief outline I shall have little more than time to mark the stepping-stones in that onward march; to trace the details would take volumes." And again (page 23), "In this brief outline of what photography has done, and is doing, much has been omitted for want of space," and I may add that when I began to collect the facts, I thought I should have no difficulty in putting within the limits of my address a fairly complete outline of the *steps* by which astronomical photography has risen to its present importance, but I found I was mistaken, and obliged to leave out many important facts that I had collected about the more recent work. Some others were accidentally omitted; amongst these was a reference to Prof. Barnard's valuable steps of progress. It was his work on the Milky Way, in 1889, that suggested to me to take up similar work here, and this was acknowledged at my first publication of that work. Other facts have come to my knowledge since. For instance, I have learned that it was his early success as an amateur in astronomical photography, that gave to the world, in the person of Dr. Gill, one of the leading astronomers of to-day; for it was that which induced him to accept Lord Lindsay's offer and adopt astronomy as a profession. Reference to Dr. Gill's more recent work, which has had so much influence in accelerating the progress of astronomical photography, was quite unintentionally omitted.

H. C. RUSSELL.

Observatory, Sydney,
25th November, 1894.

Science Notes.

Summarizing the very carefully compiled and systematized facts detailed in the last annual report of the United States Bureau of Ethnology, Mr. J. W. Powell, the director, concludes that tattooing, or face painting, is still, or was very recently, resorted to in various parts of the world for many purposes besides the specific object of tribal, clan, or family designation, and also apart from

the general intention of personal ornament. He enumerates seventeen purposes, as follows :—1, To distinguish between free and enslaved, without reference to the tribe of the latter; 2, to distinguish a high and low status in the same tribe; 3, as a certificate of bravery, exhibited by supporting the ordeal of pain; 4, as marks of personal prowess, particularly; 5, as a record of achievements in war; 6, to show religious symbols; 7, as a therapeutic remedy for disease, and 8, as a prophylactic against disease; 9, as a brand of disgrace; 10, as a token of a woman's marriage, or sometimes, 11, of her marriageable condition; 12, identification of the person, not as tribesman or clansman, but as an individual; 13, to charm the other sex magically; 14, to inspire fear in the enemy; 15, to magically render the skin impenetrable by weapons; 16, to bring good fortune, and 17, as the device of a secret society.

The ethnologist and sociologist will not fail to recognize in some of these conclusions the close relationship between customs among people low down in the scale of human evolution, and customs, with the necessary variants, among people of the highest culture at the present day. It is remarkable, too, that there exist tribes or clans of people but little advanced from the palæolithic stage, among whom tattooing, or face painting, is unknown; among others, the inhabitants of Rossel Island, New Guinea, and some of the natives on the north-east mainland. The former do not even know the use of pottery, but according to Macgregor (official despatch, 6323, 1891, p. 197), "the men carry sponges to wash their faces," and the latter (1892 despatch) "wear (many of them) the hair in long, matted ringlets, some of the men wear false whiskers." How long they will remain in this primitive state of unpainted cleanliness is doubtful. Tattooing (Haddon) "has spread to a certain extent among the Papuan hill tribes of the Peninsula, the Koitapu women appear to have thoroughly followed the fashion of their Motu neighbours." The *motif* here would come under conclusion 13: "to charm the other sex." Its variant among the females of the hairy Aino people of Japan at the present day takes the form of a painted moustache, which is not unpleasing, and in varying degrees of artistic, expressive, or necessarily lavish application, it can be studied any night to advantage when Irving, as the good Hamlet, speaks these words: "Now get you to my lady's chamber, and tell her, let her paint an inch thick, to this favour she must come; make her laugh at that."

Latest advices from America, relating to the progress of the Cataract (Electric) Construction Company's works at Niagara, are of a most encouraging nature. That, with its far-reaching and indeed almost illimitable economic possibilities, combined with the recent exploration and description of the even greater Hamilton River Falls of Labrador, suggest reflections on the rate of river recession under certain geological conditions. The recession of the River Niagara, from Lake Ontario to the present Falls, has been calculated at the rate of from one to three feet per annum; in all, thirty-six thousand years. In one of his biological lectures before the Catholic University of America, Dr. Shufeldt, dealing with the subject of river erosion, said: "If the comparatively short and shallow gorge of the Niagara River takes thirty-six thousand years to be carved back to its present site, I beg to leave it to your imagination how long it took the Colorado River to find its present bed, a mile below the surface of the earth, and for a distance of three hundred miles in length."

It is interesting to note that the distance of the Hamilton River Falls is also almost exactly three hundred miles, and taking the Niagara River recession as a basis of calculation, and allowing for differentiations in the varying resisting hardness of rock, &c., penetrated, the time in either instance cannot be intelligibly set down in figures.

Intelligence has been received of a fallen "meteoric stone" at Raschanya, Russia, of "unparalleled dimensions," but up to the present no reliable particulars are to hand of the most important factor, namely, its component parts. As in the case of others previously examined, it will probably be found that this new visitant is of the earth earthy. The problem of its original volcanic habitat involves important points, which need not be subject of speculation at the present.

That Lord Kelvin should have expressed his confidence in the practicability and scientific value of the recent discoveries in the production of electricity, otherwise than by the expensive dynamo, by two young Scotchmen, is in itself an important fact. Working on a broad platform of accredited data, these two men have made extensive experiments, and the net result, up to the present, appears to be the discovery of a primary battery in which the decomposition of the zinc plates is rendered much slower, and the chemicals used trivial in value. The strength of the battery thus formed is very greatly increased. If this proves to be the case, it will mean a great increase of power, economy of weight, and reduction of cost, thus putting aside the primary obstacle to the more general use of electricity for public and private "consumption."

The last Australian mails bring intelligence of the terrible ravages of an insect pest which bids fair to prove as destructive as the rabbits; but unlike the rabbits, without one solitary redeeming economic virtue. Mr. Box, the entomologist for the Tasmanian Government, has furnished a very able report on the subject, and points out that this underground grub is a moth; not anything like the May bug, which takes three years to reach maturity. He has called it the "grass grub." The insect matures in one year, and when fully developed covers the pasture lands like a plague of locusts. The grass grubs, says Mr. Box, "may be seen flying about in the evening just after sunset in the months of December and January over the surface of the pasture fields, where they deposit their eggs at the roots of the grass, and where the young grubs can get food immediately they are hatched." He thinks these grubs are hatched "just after the first autumn rains, when they commence to feed upon growing grass and continue to feed all the winter until the beginning of spring," thus doing an incalculable amount of damage. His personal observations on the life-habits of this new (?) pest are apparently exact, and will prove interesting to entomologists :—"In the month of June I found them just under the surface of the ground about half an inch long. In July and August they had increased in length to an inch and an inch and a half, burying themselves in the ground, and covering their holes with a web, from which they emerge every evening to feed. During the month of September they will eat of the grass close to the ground, letting the upper part remain untouched, which causes the fields affected with them to have a withered appearance. This is generally the time when they are noticed first, but it is in fact the time when they have almost completed their work of destruction. After they have attained their full size, which is about two inches in length, they turn to a chrysalis, and then to a brown moth."

No animal in existence, not even careless man, has done more to spread far and wide infectious disease among farm stock than the dog. But a more serious charge has been brought against the dog by Dr. Megnin in a lecture before the Paris Academy of Science. When practising as a veterinary surgeon, previous to taking his degree of medicine, Dr. Megnin frequently had dog patients under his care, suffering from infection of consumptive tuberculosis. He holds that dogs are not only peculiarly sensitive to such infection, but readily convey it to the human companion. Dr. Megnin traces rabies (hydrophobia, &c.) to filthy feeding. There are many facts in favour of that theory, and against the "heat" now so industriously propagated by panic-imposed muzzling orders, as, for instance, the terrible plague of hydrophobia that raged in Greenland and Baffinland a few years ago.

One of the effects of the recent terrific gales was to drive on to the north-east and east coasts of Scotland, and the coasts of Northumberland, Yorkshire, and Lincolnshire an extraordinary number of little auks (*Mergulos albis*), glaucous gulls (*Larus glaucus*), and a few barnacle geese (*Bernicla leutopsis*), all non-indigenous British birds.

THE BASS ROCK AND ITS WINGED INHABITANTS.

By HARRY F. WITHERBY.

VISIBLE for miles around, and rising abruptly to a height of four hundred and twenty feet above the sea, the Bass Rock with its clear-cut outline and imposing grandeur forms a most striking feature at the mouth of the Firth of Forth. This noble old rock is about a mile in circumference, and is situate three and a quarter miles east-north-east of North Berwick, and some two miles from the shore; its sides which face the open sea are precipitous, while that side which lies towards the land rises in a long grassy slope.

Undoubtedly, the principal interest in the Bass Rock at the present day lies in the fact that it is one of the greatest breeding stations for sea birds round the coasts of Great Britain. In times gone by, however, it was celebrated both as a fortress and a prison.

The first authentic record of this rock having been inhabited dates back to the beginning of the seventh century, when St. Baldred, a hermit, took up his abode there; and though during many years afterwards the Bass was a fortified place, it is impossible to trace precisely when this change came about. The earliest mention of its being so used was in the year 1405, when Prince James (afterwards James I. of Scotland) took refuge there, and a few years later it was used as a prison for the Duke of Albany, who had acted as regent for the young prince. The ancient family of the Lauders are said to have been the first owners of the Bass, and they held possession of it for about five hundred years, until in 1626 it was appropriated by Charles I. Some few years afterwards, when Scotland was threatened with invasion by Cromwell from England, the public records of the Church of Scotland were sent for security to the Bass Rock; but Cromwell captured the Bass, as he did all Scotland's other strongholds, and forwarded the valuable documents to the Tower of London. In 1671 the island, being then in possession of Andrew Ramsey, was purchased by the Government of Charles II. for the purpose of a State prison, after which it became noted as the prison in which the leading Covenanters were confined.

It is interesting to note that the Bass was the last spot in the British Isles to hold out for James II., but it was captured in 1694, and in 1701 was dismantled of its fortifications by command of William III. Five years afterwards it again became private property, passing into the hands of Sir Hew Dalrymple, and since that time the buildings have been allowed to decay, and the rock has been rented mainly for the sake of the eggs and flesh of the many sea birds which resort there throughout the breeding season. Besides numerous rabbits which thrive on the rich grass growing at the top of the rock, sheep used to be kept there in limited numbers, but being unable to obtain a good supply of water they did not flourish. Bass

FIG. 1.—Eider Duck on Nest.

mutton, however, always commanded a good price, and we have heard that there was often more "Bass mutton" in the market than was ever on the Bass.

The most numerous inhabitant of the rock is the solan goose or gannet; and, like other dwellers on the islet, it boasts a place in history, for the oldest records of the Bass mention this bird as breeding there in great numbers.

When the gannet first came to nest on the rocky ledges of the Bass is not known; but geologists have a theory that this rock of volcanic origin was once in the form of a sloping mound, and that, as the softer covering of *débris* was worn away by wind and sea, the unyielding rock was left as we now see it. Certainly the birds took up their abode on the Bass after this denuding process was complete, for they could not build their nests were it not for the broad ledges which now rise up in tiers from the bottom to the top of its precipitous sides.

It was in the month of August that I paid my first visit to the Bass, and grand as the sight then was, it was infinitely more so when I visited it again in the month of May at the height of the breeding season. After a pleasant drive from North Berwick on a beautiful summer day, our party arrived at Canty Bay, which lies just opposite the rock. Here we found a boat waiting, and even as we were getting on board we could catch a glimpse, as the sun lighted on them, of countless white objects whirling round the rock just two miles to seaward.

As we rowed out, every now and then a gannet would fly over our heads, seemingly but a few yards above us, and appearing to be quite a small bird, notwithstanding the fact that it measures on the average five feet ten inches across the wings. It is very often the case on a clear day, and especially at sea, that a large bird appears to be very close, when in reality it is a considerable distance away. The nearer we approached the rock the more numerous the birds became. Guillemots, in their beautiful breeding

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plumage of velvety brown on the back and head, and white on the under parts, were swimming about in companies, while here and there amongst them a razorbill was conspicuous by its black shining back and clumsy-looking beak marked with a white vertical stripe. As soon as we were within twenty or thirty yards of these birds, they dived down with the rapidity of lightning, and, swimming under water, reappeared some fifty or sixty yards further on.

Unlike divers such as the cormorants and the crested grebe, the guillemot and razorbill do not jump out of the water as they dive, but, putting down the head and lifting up legs and tail, they go down perpendicularly. Moreover, so quickly is this action performed that, when fired at from a distance of about thirty yards, the bird will often dive at the flash of the gun, and evade the shot which strikes the very spot on which it was swimming but a moment before. Under water these birds can travel with considerable rapidity, both feet and wings being used as propellers. Their movements in a glass tank afford an interesting and beautiful sight. When a fish is thrown into the water, the guillemot immediately dives down, and as it proceeds under the water with slow but graceful beats of the wing, a track of silvery air bubbles, like a chain of glistening pearls, is left in its wake.

But to return to the Bass. When within a hundred yards or so of the rock, we came upon a number of that strange-looking bird, the puffin or sea parrot. Unlike the guillemots, they did not dive at our approach, but rose from the water and flew away with a short quick flight. We did not land immediately on reaching the island, but rowed round it, and the sight from this point of view was simply marvellous. Thousands upon thousands of gannets, and scores of kittiwake gulls, were wheeling about in the air uttering the most weird and discordant cries, while every available ledge from about sixty feet above the sea to the top of the rock was occupied by gannets, guillemots, razorbills or kittiwakes. The more one gazed at this ever-moving mass of birds the more wonderful and awe-inspiring did it appear. It has been estimated that about five thousand pairs of gannets nest on the Bass alone.

As we rowed round, a large opening in the rock attracted our attention, and we were told that this was the entrance

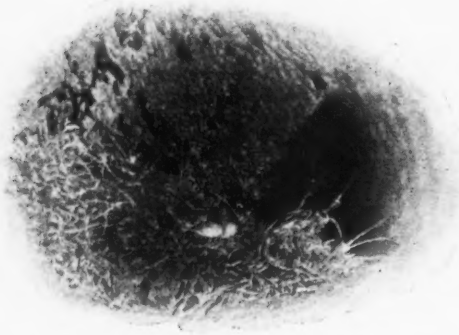


Fig. 2.—Herring Gull's Nest and Eggs.

to a tunnel about thirty feet high and one hundred and seventy yards in length, which passes right under the island from east to west. A cormorant was sitting on a ledge at the entrance, and several of these birds had built their nests inside the cave.

Very little swell or rough water makes it a difficult task to land on the Bass, in consequence of the great rise and fall of the sea. No difficulty, however, was experienced on this beautiful May day. On landing we soon climbed up to the entrance of the ruined castle, and just as we were about to step in, an eider duck flew off her lovely nest of dun-coloured down, imbedded in which were five dull green eggs. Just within the low and narrow doorway

Fig. 3.—Gannet defending Nest.
(From an instantaneous photograph.)

leading into the roofless old castle we were surprised to find, in the shadow of the walls, another eider duck's nest, upon which the female bird was sitting. The bird's neck was bent back, and her head, resting between her folded wings, seemed to rise straight out of the middle of her back. This bird proved exceedingly tame, allowing a cautious approach to within five feet of the nest, and then remaining perfectly still while the Kodak was brought to bear on her (Fig. 1). The eider duck was not the only inhabitant of the castle. Every now and then a puffin flew in or out of a hole in the old walls. I rashly attempted to climb up to one of the holes, some twenty-five feet from the ground. The walls of the castle are formed of large blocks of sandstone built up together with mortar, but the mortar having fallen away, the projecting stones form an easy foothold. I had reached the hole from which a puffin had flown out, and was leaning over to get its single white egg, when the great stone to which I was clinging suddenly gave way, and, just grazing my head, crashed to the ground. By clutching at a firmly-set stone below, I managed to escape falling upon the jagged rocks on which the wall was built.

It was very strange to find on this sea-girt rock a homely blackbird, sitting upon a nest of four eggs. There being no tree or shrub in which the birds could build their nest, they had placed it in a chink of the castle wall. Whether they foraged for food on the rock, or flew across to the mainland, I do not know. As we mounted up the grassy slope to the top of the rock, the white scut of a rabbit every now and then appeared; and the only bird found breeding on this part of the island was the herring gull.

Several nests, loosely formed of feathers, grass, and sticks, and containing two or three straw-coloured eggs, spotted and blotched with rich brown, were placed in a hollow scraped in the ground (Fig. 2). The gulls, however, were very wild, rising off their nests as soon as they caught sight of us. Leaving the grass, we walked round the edge of the rock, from which a fairly good view can be had of the countless number of birds breeding on its precipitous sides, and two of our party climbed a long way down amongst them. Jumping, or clambering down, from ledge to ledge, one could not proceed without treading on a gannet's nest here and there, so thickly were the ledges populated. Moreover, the gannets were so bold, that they stood up in the nests, and flapping their wings, croaked and pecked at the intruders, each holding down the solitary egg with the webbed foot all the while. An old bird was provoked to this position, and the camera brought to bear on her (Fig. 3), but, as will be seen in the figure, she had almost closed her wings before the plate was exposed. This bird's peculiar habit of holding down its egg no doubt gave rise to the old belief that the gannet hatched its egg with its foot. The nest of the gannet is flat and round, and is formed for the most part of seaweed, but anything, such as sticks and straw, that the bird finds floating on the sea, is picked up and heaped upon the nest. The nests are added to from year to year, and consequently some of them are of a considerable height; moreover, they are extremely filthy, swarming with vermin, and emit a disagreeable smell.

When first laid the egg is pale blue, overlaid with a layer of chalky white, but it soon becomes dirty, until when hard set, it can scarcely be distinguished from the nest itself. Several young birds were hatching out as we climbed down. When just hatched, the young gannet is a curious object; a large head and beak protrude from a bluish-black naked mass. As the bird grows, however, this black skin is covered with beautiful white down, which in its turn is replaced by deep brown feathers, speckled with white (Fig. 4). At each moult the white on the bird's feathers increases, until when from three to five years old (the exact age has not yet been ascertained) the gannet comes to maturity, dressed in a plumage of shining white, with black-tipped wings and cream-coloured head.

The young are at first fed with half-digested fish given to them by the old birds, and as they grow stronger whole fish are brought to them; but the parent birds never carry food to the young in the beak—they invariably swallow the fish and eject it upon reaching the nest. It is a curious fact that if the gannet has any undigested food in its stomach as it is about to fly from its nest, the food is disgorged and deposited near the nest; and when the young are old enough to feed themselves they scoop up these half-digested fish with their beaks and swallow them.

After attaining their first plumage, and when they have become plump, the young are collected by the lessees of the Bass. They are plucked, flayed, roasted, and sold for eating at a few pence each. A certain amount of oil which is extracted from the skin and entrails was formerly used as a remedy for gout, but is now generally employed as grease for cart-wheels. The feathers when properly prepared and freed from their fishy smell, also have their market value, so that little of the bird is wasted.

Perhaps the most interesting habit of the gannet is the way in which it obtains its food. Flying along at about one hundred feet above the sea, the bird espies a herring, mackerel, or some other fish which swims near the surface of the water, and suddenly stopping its onward flight, it trembles in the air for a moment as if to take aim, but only for a moment, when, with closed wings, it drops into the water like a stone. Scarcely has the great splash caused by its fall subsided, than the bird rises to the surface with its prey, and floating for a moment swallows the fish, and then mounting into the air resumes its onward flight. Often as this feat is performed, the gannet very rarely fails to capture the fish at which it aims. In some parts of the coast these birds are caught by the fishermen by fastening a herring to a board and floating it on the sea. The gannet diving down upon the fish, is stunned or killed by the board, which is often transfixed by its beak. In the winter, when the gannets leave their nesting-places and distribute themselves round the coast, their arrival is always hailed by the fishermen as a sure sign that fish are in the neighbourhood.

There are several points in the anatomy of the gannet well worthy of attention. Its nostrils are closed, the tongue is aborted, and the feet are webbed; but the chief peculiarity in the structure of this remarkable bird is the presence of a large number of air cells throughout almost the whole surface of the body. Some of these air cells are very large, and they all communicate with the lungs, and can be inflated or emptied at will.

The distribution of the different species of birds was very noticeable as we climbed down the precipitous sides of the

FIG. 4.—Young Gannet in the first plumage.

Bass. From the top to about half the distance down, the gannets had monopolized every shelf, but the lower we climbed the less numerous the gannets became, their place being taken by rows of guillemots and razorbills, which lay their eggs on the bare rock, and therefore the contrast between the ledges occupied by the gannets and those used by the guillemots was remarkable. The former were covered with dirty nests and strewn with every kind of rubbish, while those on which the guillemots were sitting were comparatively clean. Both the guillemot and the razorbill lay a single egg of a large size, the guillemot always choosing an open position on which to deposit its egg, while the egg of the razorbill may usually be found in a small crevice, or in some more or less sheltered ledge. The reason for this difference in the habits of the two birds may, perhaps, be found by examining the respective shapes of the eggs. The guillemot's egg is pyriform, being very broad at one end and pointed at the other, and this causes it to revolve on its own axis should it be touched or should the wind blow it. The razorbill's egg, on the other hand, has not this shape, and the bird no doubt places it in a crevice for safety. But this is not the only difference in the breeding

habits of the two birds, for while the razorbill lies along the egg, placing it between one of its wings and its body whilst incubating, the guillemot sits upright upon hers, holding it in a cavity formed in the feathers between her legs.

The razorbill's egg forms a very striking object, being of a white ground colour, spotted and blotched with black. The guillemot's egg is remarkable for its great variety of colouring, and although generally of a bluish-green of varying shades, marked with rich brown spots and streaks, eggs may be found of all shades, from a light blue to one identical in colouring with that of the razorbill. The shape of the guillemot's egg is not an invariable safeguard to its rolling off its precarious resting-place, for coming suddenly round a corner of a ledge I disturbed a guillemot, and in flying from her egg she caused it to roll off the shelf. It struck a gannet on the head in its downward course, and finally landed in the nest of another gannet, which immediately devoured it.

Those extremely elegant little gulls, the kittiwakes, were the only other birds breeding on the rock, although at times a peregrine falcon takes up its abode on one of the most inaccessible ledges. The kittiwake builds a fairly large nest of seaweed, and lays two or three eggs of greyish-white marked with rich brown. It always selects a narrow ledge, difficult of access, and we could find no nests of this bird on the Bass which could be reached without a rope. This gull is a very late breeder, not commencing to lay until about the end of May, so that when the close season expires at the beginning of August there are always unfledged young ones in a great many nests. So ardent a desire is there, however, among the weaker sex for the skin of this elegant bird to adorn the hats, that hundreds of the old birds are slaughtered annually, while their young are still unable to provide food for themselves, and a lingering death to the nestlings is generally the consequence.

In conclusion, let me recommend to all lovers of British sea birds a visit to the Bass Rock, where so many species may be found, and where their life-history may so easily be observed.

RECENT WORK ON DIPHTHERIA AND ITS PREVENTION.

By James C. Hoyle, M.B., M.R.C.S., D.P.H.

CONSIDERABLE attention has lately been given by the medical and lay press to the subject of diphtheria. This arises from two causes. Firstly, because, unfortunately, the disease has shown a marked tendency to become more general, and secondly, because recent investigation has resulted in discoveries which we may confidently hope will prove successful in combating this disease.

The popular idea of diphtheria is undoubtedly a sore throat of a very bad and sometimes fatal kind, and this is dimly associated in the lay mind with "drains." Scientific investigation has proved that diphtheria depends upon the inoculation of some part of the respiratory passages with a tiny micro-organism—the bacillus diphtheriæ. The microbes multiply around the seat of inoculation, and generate a poison which produces in the patient some or all of the symptoms of the disease. The local changes are characterized by inflammation and the formation of a yellowish membrane covering the affected parts.

These recent discoveries are most opportune, as both the total number of cases and the percentage mortality have been steadily increasing of late years; while the disease, which formerly mainly affected rural districts, has shown a tendency to find a home in large towns and cities.

In London this has been very marked, as the following statistics will show:—

In 1890 there were 5870 cases of diphtheria "notified" by local medical officers of health to the Metropolitan Asylums Board. In 1893 the number of cases had risen to 13,026. The disease was also more fatal.

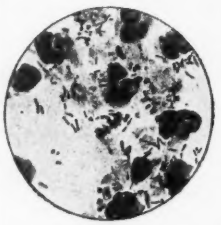
London Death Rate per Million Persons Living, per Annum:

Years.	Diphtheria.	Diseases of throat, not diphtheria.	Total.
1881	172	321	493
1891	340	177	517
1893	760	120	880

Diphtheria Deaths per Million Persons Living (Mean Annual Death Rates):

	1881-3.	1884-6.	1887-9.	1 9 -2.
England and Wales	144	163	173	192
London	2 3	227	315	377

There is reason to believe that part of this increase is more apparent than real, for better medical knowledge has rendered the recognition of obscure cases easier. This view is strengthened by the fact that with the increase in diphtheria there has been a decrease in the death rate from diseases of the throat, other than diphtheria. Undoubtedly many cases of what was formerly called "croup" were really diphtheritic. It has been estimated that eighty-two per cent. of the deaths from diphtheria occur in children under ten years of age, and there are few families where this fact will not be painfully endorsed.



A.—From the false membrane of human diphtheria of the fauces. The rods are the bacilli; the dark masses are tissue cells.

This being the present unsatisfactory state of affairs, it behoves everyone to consider what can be done to ameliorate matters. Sanitarians in particular, and medical men in general, ought to receive far more confidence and support from the laity than that which is accorded them. Measures and precautions suggested by a knowledge of the causation and danger of infectious diseases, whether enjoined by statute or not, should be welcomed as part of the fight which science is ever waging against disease, and a more grateful recognition of the labours of original investigators would honour alike the State and the worker.

To leave the dry bones of percentages and death rates, let us consider some of the factors which sanitarians have named as being concerned in the production of this disease. First comes "drains." It is very difficult to say what is the precise relation that defects in drainage bear to the production of diphtheria. Broadly, it may be stated that where sewers and main drains are defective, there the soil and surface-water will become foul and germ-laden, and sewer gas and other emanations will readily enter premises where the sanitary arrangements are obsolete or defective; yet cases occur in houses where the sanitation is above suspicion. Next we must consider the risk and danger arising from direct infection. Remembering that the bacillus is discharged in the mucus from the respiratory passages of a patient, one would naturally expect to trace direct infection in the majority of cases. Sometimes this evidence is very clear; for instance, medical men have themselves contracted the disease from a patient, either by the sufferer coughing into the doctor's face, or when during the performance of the operation known as

tracheotomy (opening the windpipe in the neck to relieve impending suffocation, caused by the membrane formed in this disease) the surgeon has courageously attempted to assist Nature, by applying his lips to the tube inserted in the neck.

To sum up briefly certain results gained by investigation on lines suggested by these facts, it may be said that in a family where one patient is suffering from diphtheria, other members are likely to have sore throats, and many of these subsequently develop the disease. From the throats of those exposed to infection, but not showing signs of the disease, cultivations of the bacillus diphtheriæ can often be obtained, and it is probable that this latter class may help to transmit the disease. Further cultivations of the specific bacillus have been obtained from the throats of patients some weeks after apparent convalescence; a fact which suggests the necessity of using antiseptic gargles and sprays for some time after all symptoms have disappeared.

Dr. Thorne Thorne, Principal Medical Officer to the Local Government Board, in his Milroy Lectures, delivered before the Royal College of Physicians of London, has shown the part played in propagating epidemic diphtheria by elementary schools where many children are in close contact with each other in rooms too often ill-ventilated. I may here remark that the cubic floor space per child allowed in Board schools is far too little, and there can be no doubt that this is a serious factor in the dissemination of this and other contagious diseases. In the large blocks of workmen's dwellings, often euphoniously but incorrectly called "models," the percentage of cases is higher than in other more separated dwellings, and this arises from causes similar to what I may call the school propagation.

Passing by these two factors, which after all merely account for the increase and not for the causation of the disease, evidence has of late years accumulated which tends to show that the lower animals sometimes suffer from diphtheria, and so may be sources of danger. Cats are sometimes affected by the disease, and the domestic tabby, at once perchance a sufferer and the common playmate of several juvenile members of a family, may be the innocent means of a good deal of harm. The cat may contract the disease independently or by direct infection from a child. It follows, therefore, that doctors and heads of households, when dealing with a diphtheria case, should keep a watchful eye on any pets, and should banish them from the sick room. Cows may suffer from what is known as bovine diphtheria, a disease mainly affecting the skin of the udders and the internal organs, such as the kidney. Several epidemics have been traced to milk derived from infected cattle, and from the causation of these epidemics means can, fortunately, be taken to cut at the root of the mischief.

I have before attributed the symptoms of diphtheria to a poison—a toxine as it is called—developed by the specific bacilli. If these are grown on suitable material, such as gelatine, broths, or in milk, and some be injected into an animal—for instance, a guinea pig, or horse—the animal, presuming the dose to be sufficiently large, will contract diphtheria. It has also been noted that the virulence of the bacilli can be modified by growing them at different temperatures, and by using cultivations of different ages; and these "attenuated cultures" can be introduced into animals without giving them diphtheria. Further, it has been shown that if the virulence of these cultures be gradually increased, the animals into which they are injected may be rendered insusceptible. From this it was argued—and the argument was suggested by a knowledge of the bacteriology and pathology of other kindred infective diseases — that in these artificially immune animals a body was developed which neutralized the action of the toxine.

Recent observers have shown that these immunity-giving bodies—the antitoxin—are contained in the blood; and that the serum derived from the blood of these immune animals also contains this body. The result of this research has lately been utilized in a twofold direction. If a small quantity, say ten or twenty cubic centimètres, of the antitoxin serum be injected into animals susceptible to diphtheria, and they then be inoculated with the bacillus diphtheriæ, they will not (provided that the dose of the bacillus be not too large) contract the disease, being protected by the antitoxin. Certain limits of the toxine dose have to be observed, as the protective influence of the antitoxin appears to weaken somewhat in cases of profound toxine poisoning, and this may explain some of the apparent failures of the treatment in actual practice. Nevertheless, the serum has been successfully used as a preventitive inoculation in persons who are exposed to infection, and clinical evidence shows that such injections confer a real though temporary immunity. It has also been found that if the antitoxin be injected in suitable doses into a patient suffering from diphtheria, the disease is practically cut short, the expulsion of the membrane rendered easy, and the dread symptoms of collapse and paralysis prevented or ameliorated. The fever also may be markedly reduced. The injection appears to be harmless, even to persons not suffering from the disease.

B.—From a colony of the bacillus diphtheriæ (human) grown on gelatine.

Enough evidence has not yet accumulated to prove that the remedy will stand the test of time, but sufficient light has already been shed on the subject to show that in the antitoxin we possess a most hopeful remedy. Popular prejudice is hard to overcome, but it may be hoped that the remedy will be given a fair trial, and though extended experience may suggest modifications in the technique of the treatment, it seems not too much to hope that experimental science has at length gained an important point in its struggle against this fell disease.

A systematic investigation of the throats of those exposed to infection is very helpful, and in America has been attempted on a large scale. In New York, physicians having doubtful cases can obtain the assistance, gratis, of public experts, who examine bacteriologically material from the throat, and who report definitely within thirty-six hours on the case. It is greatly to be wished that some such State aid could be given to the medical profession in England.

The Goldsmiths' Company, with enlightened generosity, have given £1000 to the laboratories of the Royal Colleges of Physicians and Surgeons in London, in order to promote further investigation into the nature and action of the remedy, which has been successfully used in the diphtheria wards of the Metropolitan Asylums Board hospitals, and which is now being prepared at no less than five scientific institutions in London.

Much good may be and is being daily done by rigid and careful isolation of infected patients, by attending to the hygiene of places where many, particularly the young, congregate; by seeking to give to the poor and rich alike the blessings of light and pure air and water; but the richest reward will surely await those who by laborious research,

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often unrecognized by their contemporaries, endeavour to carry out to the full prevention, which is better, and cure, which is good.

We are indebted to Messrs. J. and A. Churchill for their kind permission to use the two foregoing illustrations, which are taken from Stevenson and Murphy's "Treatise on Hygiene."

THE FACE OF THE SKY FOR FEBRUARY.

By Herbert Sadler, F.R.A.S.

SOME fine groups of spots have recently appeared on the solar disc. Conveniently observable minima of Algol occur at 9h. 26m. P.M. on the 4th; at 6h. 15m. P.M. on the 7th; at 11h. 8m. P.M. on the 24th; and at 7h. 57m. P.M. on the 27th.

The Zodiacal Light should be looked for after sunset in the south-west during the absence of the Moon.

Mercury is an evening star, and is fairly well situated for observation during the first fortnight of the month. On the 1st he sets at 6h. 10m. P.M., or 1h. 22m. after the Sun, with a southern declination of 13° 11′, and an apparent diameter of $5\frac{3}{4}''$, $\frac{82}{100}$ths of the disc being illuminated. On the 5th he sets at 6h. 31m. P.M., or 1h. 35m. after the Sun, with a southern declination of 10° 19′, and an apparent diameter of $6\frac{1}{4}''$, $\frac{69}{100}$ths of the disc being illuminated, and the planet being now at his brightest. On the 10th he sets at 6h. 50m. P.M., or 1h. 47m. after the Sun, with a southern declination of 7° 1′, and an apparent diameter of $7\frac{1}{4}''$, $\frac{47}{100}$ths of the disc being illuminated. On the 16th he sets at 6h. 46m. P.M., or 1h. 22m. after the Sun, with a southern declination of 4° 33′, and an apparent diameter of $8\frac{3}{4}''$, $\frac{23}{100}$ths of the disc being illuminated. After this he approaches the Sun too closely to be observed. He is at his greatest eastern elongation ($18\frac{1}{2}$°) at 5h. P.M. on the 9th, and in inferior conjunction on the 25th. At 1h. P.M. on the 1st he is in conjunction with Venus, 0° 35′ to the north of her; and again at the same hour on the 10th, 2° 38′ to the north of her. These conjunctions will afford excellent opportunities for picking up the planet on the evenings of the 1st and 10th. While visible Mercury describes a direct path in Aquarius, being near the $5\frac{1}{2}$ magnitude star 38 Aquarii on the evening of the 2nd.

Venus is an evening star, and is gradually getting into a better position for observation. She sets on the 1st at 6h. 7m. P.M., or 1h. 19m. after the Sun, with a southern declination of 13° 46′, and an apparent diameter of $10\frac{1}{4}''$, $\frac{97}{100}$ths of the disc being illuminated. On the 10th she sets at 6h. 36m. P.M., or 1h. 34m. after the Sun, with a southern declination of 9° 40′, and an apparent diameter of $10\frac{1}{4}''$, $\frac{96}{100}$ths of the disc being illuminated. On the 20th she sets at 7h. 8m. P.M., or 1h. 47m. after the Sun, with a southern declination of 4° 42″, and an apparent diameter of $10\frac{1}{2}''$, $\frac{94}{100}$ths of the disc being illuminated. On the 28th she sets at 7h. 35m. P.M., or two hours after the Sun, with a southern declination of 0° 34′, and an apparent diameter of $10\frac{3}{4}''$, $\frac{93}{100}$ths of the disc being illuminated. We have alluded above to her conjunctions with Mercury. During the month she pursues a direct path through Aquarius into Pisces, but does not approach any conspicuous star very closely.

Mars is an evening star, but is rapidly getting fainter and smaller. He sets on the 1st at 1h. 40m. A.M., with a northern declination of 17° 39′, and an apparent diameter of 8·0″, the phase on the *n f* limb amounting to 0·9″. On the 15th he sets at 1h. 27m. A.M., with a northern declination of 19° 46′, and an apparent diameter of 7·1″. On the 28th he sets at 1h. 18m. A.M., with a northern declination of 21° 31′, and an apparent diameter of 6″. He is in quadrature with the Sun on the 5th. During the month he passes through a portion of Taurus into Aries, being south of the Pleiades on the 19th.

Jupiter is an evening star, and is excellently situated for observation. He sets on the 1st at 5h. 18m. A.M., with a northern declination of 23° 18′, and an apparent equatorial diameter of 44·1″. On the 11th he sets at 4h. 37m. A.M., with a northern declination of 23° 18′, and an apparent equatorial diameter of 42·9″. On the 21st he sets at 3h. 57m. A.M., with a northern declination of 23° 20′, and an apparent equatorial diameter of 41·6″. On the 28th he sets at 3h. 30m. A.M., with a northern declination of 23° 21′, and an apparent equatorial diameter of 40·6″. During the month Jupiter is almost stationary in Taurus, about $1\frac{1}{4}$° south-east of the 5th magnitude star 132 Tauri. The following phenomena of the satellites occur while the Sun is more than 8° below and Jupiter 8° above the horizon:—On the 1st a transit egress of the third satellite at 6h. 17m. P.M.; a transit ingress of its shadow at 7h. 9m. P.M., and its egress at 10h. 6m. P.M. On the 2nd an occultation disappearance of the second satellite at 0h. 9m. A.M. On the 3rd an occultation disappearance of the first satellite at 1h. 36m. A.M.; a transit ingress of the second satellite at 6h. 31m. P.M., a transit ingress of its shadow at 8h. 24m. P.M., a transit egress of the second satellite at 9h. 8m. P.M.; a transit ingress of the first satellite at 10h. 52m. P.M.; a transit egress of the shadow of the second satellite at 11h. 3m. P.M.; a transit ingress of the shadow of the first satellite at 11h. 50m. P.M. On the 4th a transit egress of the first satellite at 1h. 9m. A.M., and a transit egress of its shadow at 2h. 7m. A.M.; an occultation disappearance of the first satellite at 8h. 3m. P.M., and its eclipse reappearance at 11h. 16m. 30s. P.M. On the 5th an eclipse reappearance of the second satellite at 5h. 52m. 22s. A.M.; a transit ingress of the shadow of the first satellite at 6h. 19m. P.M., a transit egress of the satellite itself at 7h. 36m. P.M., and of its shadow at 8h. 36m. P.M. On the 8th a transit ingress of the third satellite at 7h. 0m. P.M., its transit egress at 9h. 51m. P.M., and a transit ingress of its shadow at 11h. 8m. P.M. On the 9th a transit egress of the shadow of the third satellite at 2h. 7m. A.M.; an occultation disappearance of the second satellite at 2h. 30m. A.M. On the 10th an occultation disappearance of the first satellite at 3h. 25m. A.M., a transit ingress of the second satellite at 8h. 56m. P.M., a transit ingress of its shadow at 11h. 2m. P.M., a transit egress of the satellite itself at 11h. 33m. P.M. On the 11th a transit ingress of the first satellite at 0h. 41m. A.M.; a transit egress of the shadow of the second satellite at 1h. 42m. A.M.; a transit ingress of the shadow of the first satellite at 1h. 45m. A.M., and a transit egress of the satellite itself at 2h. 57m. A.M.; a transit egress of the shadow of the fourth satellite at 6h. 8m. P.M.; an occultation disappearance of the first satellite at 9h. 52m. P.M. On the 12th an eclipse reappearance of the first satellite at 1h. 12m. 6s. A.M.; a transit ingress of the first satellite at 7h. 8m. P.M., of its shadow at 8h. 14m. P.M.; an eclipse reappearance of the second satellite at 8h. 27m. 44s. P.M.; a transit egress of the first satellite at 9h. 25m. P.M., and of its shadow at 10h. 31m. P.M. On the 13th an eclipse reappearance of the first satellite at 7h. 40m. 56s. P.M. On the 15th a transit ingress of the third satellite at 10h. 37m. P.M. The fourth satellite is in superior geocentric conjunction at 10h. 54m. P.M. on the 2nd. On the 16th a transit egress of the third satellite at 1h. 29m. A.M., and a transit ingress of its shadow at 3h. 8m. On the 17th a transit ingress of the second satellite at 11h. 24m. P.M. On the 18th a transit ingress of the shadow of the second satellite at 1h. 40m. A.M., a transit ingress of

the satellite itself at 2h. 1m. A.M.; a transit ingress of the first satellite at 2h. 31m. A.M.; an occultation disappearance of the first satellite at 11h. 43m. P.M. On the 19th an occultation disappearance of the second satellite at 6h. 8m. P.M., an eclipse reappearance of the third satellite at 7h. 55m. 18s. P.M.; a transit ingress of the first satellite at 8h. 58m. P.M., a transit ingress of its shadow at 10h. 9m. P.M.; an eclipse reappearance of the second satellite at 11h. 3m. 8s. A.M.; a transit egress of the first satellite at 11h. 15m. P.M. On the 20th a transit egress of the shadow of the first satellite at 0h. 26m. A.M.; an eclipse disappearance of the fourth satellite at 1h. 24m. 6s. A.M.; an occultation disappearance of the first satellite at 6h. 11m. P.M., and its eclipse reappearance at 9h. 36m. 36s. P.M. On the 21st a transit egress of the shadow of the first satellite at 6h. 55m. P.M. On the 23rd a transit ingress of the third satellite at 2h. 19m. A.M. On the 25th a transit ingress of the second satellite at 1h. 24m. A.M. On the 26th an occultation disappearance of the first satellite at 1h. 35m. A.M.; an occultation reappearance of the third satellite at 6h. 56m. P.M.; an occultation disappearance of the second satellite at 8h. 36m. P.M.; an eclipse disappearance of the third satellite at 9h. 4m. 7s. P.M.; a transit ingress of the first satellite at 10h. 50m. P.M.; an eclipse reappearance of the third satellite at 11h. 56m. 34s. P.M. On this evening Jupiter will appear to be attended by only one satellite, the fourth, from 10h. 50m. P.M. till 11h. 57m. P.M. On the 27th a transit ingress of the shadow of the first satellite at 0h. 4m. A.M., a transit egress of the satellite itself at 1h. 6m. A.M.; an eclipse reappearance of the second satellite at 1h. 38m. 32s. A.M.; a transit egress of the shadow of the first satellite at 2h. 21m. A.M.; an occultation disappearance of the first satellite at 8h. 3m. P.M., a transit ingress of the fourth satellite at 11h. 8m. P.M.; an eclipse reappearance of the first satellite at 11h. 32m. 19s. P.M. On the 28th a transit egress of the fourth satellite at 0h. 6m. A.M.; a transit ingress of the shadow of the first satellite at 6h. 32m. P.M.; a transit egress of the first satellite at 7h. 34m. P.M.; a transit egress of the shadow of the second satellite at 8h. 18m. P.M.; a transit egress of the shadow of the first satellite at 8h. 50m. P.M.

Saturn is an evening star, in the sense of rising before midnight, during the greater part of February. On the 1st he rises at 0h. 34m. A.M., with a southern declination of 11° 32′, and an apparent equatorial diameter of $8\frac{1}{2}''$ (the major axis of the ring-system being $38\frac{1}{2}''$ in diameter, and the minor $12\frac{1}{4}''$). On the 10th he rises at 11h. 55m. P.M., with a southern declination of 11° 32′, and an apparent equatorial diameter of $8\frac{3}{4}''$ (the major axis of the ring-system being $39\frac{1}{2}''$ in diameter, and the minor $12\frac{1}{2}''$). On the 28th he rises at 10h. 43m. P.M., with a southern declination of 11° 25′, and an apparent equatorial diameter of 9″ (the major axis of the ring-system being $40\frac{3}{4}''$ in diameter, and the minor $12\frac{3}{4}''$). Titan is at his greatest eastern elongation at 1·4h. A.M. on the 11th, and 0·5h. A.M. on the 27th. Saturn is nearly stationary in Virgo during February, about $2\frac{1}{2}$° north-east of λ Virginis,

Uranus does not rise before midnight on the last day of the month.

Neptune is an evening star, and is still favourably situated for observation. He rises on the 1st at noon, with a northern declination of 20° 54′, and an apparent diameter of 2·6″. On the 28th he sets at 2h. 18m. A.M., with a northern declination of 20° 55′. He is almost stationary during the month to the south-west of ι Tauri. A map of the small stars near his path will be found in the *English Mechanic* for September 7th, 1894.

February is not a very favourable month for shooting stars.

The Moon enters her first quarter at 0h. 16m. A.M. on the 3rd; is full at 5h. 23m. P.M. on the 9th; enters her last quarter at 1h. 9m. P.M. on the 16th; and is new at 4h. 44m. P.M. on the 24th. She is in perigee at 1h. P.M. on the 9th (distance from the earth, 221,630 miles), and is in apogee at 7h. P.M. on the 22nd (distance from the earth, 252,580 miles).

Chess Column.

By C. D. Locock, B.A.Oxon.

COMMUNICATIONS for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 12th of each month.

Solutions of January Problems.

No. 1. (A. G. Fellowes.)

1. Kt to B3ch. 2. P to Q4ch. 3. P to Kt5ch.
4. Kt to Q5ch. 5. P to B7ch. 6. Kt to Kt6ch.

CORRECT SOLUTIONS received from Alpha, W. Willby, A. Louis, F. V. Louis, N. Alliston, A. Rutherford, E. W. Brook.

No. 2. (C. D. Locock.)

1. B to QB5 and mates next move.

CORRECT SOLUTIONS received from Alpha, W. Willby, G. G. Beazley, A. Louis, F. V. Louis, J. T. W. Claridge, N. Alliston, H. S. Brandreth, R. S. Lacey, E. E. Pocock, A. Rutherford, F. H. Bolton.

E. W. Brook.—No. 2 was a two-mover.

J. T. Blakemore.—The Queen mates at KBsq.

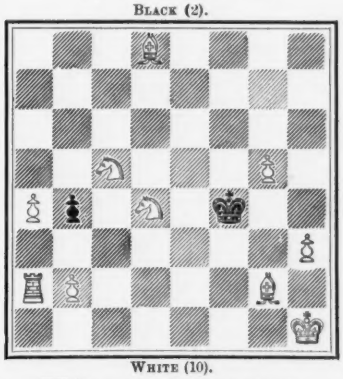
J. St. L. Kirwan.—Your problem can be solved in one move by placing the Black Rook at QKt7; or in two moves by placing it on any square in the fifth row, followed by 1. B to Kt2ch.

N. Alliston.—We fear that your three-mover has a second solution, commencing with 1. Kt to Kt5, and a third by 1. Kt to B2.

PROBLEM.

By A. G. FELLOWES.

BLACK (2).



WHITE (10).

White mates in four moves.

The following game was played in the Dresden International Tournament last summer.

"French Defence."

WHITE. Dr. Tarrasch.	BLACK. C. Walbrodt.
1. P to K4	1. P to K3
2. P to Q4	2. P to Q4
3. Kt to QB3	3. Kt to KB3

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4.	B to KKt5	4. B to K2
5.	B × Kt	5. B × B
6.	P to K5	6. B to K2
7.	Q to Kt4 (*a*)	7. Castles !
8.	B to Q3	8. P to KB4 (*b*)
9.	Q to R3 (*c*)	9. P to B4
10.	P × P	10. Kt to B3 !
11.	P to B4	11. B × P (*d*)
12.	Castles	12. Q to R4
13.	K to Kt1	13. P to Q5
14.	QKt to K2	14. P to QKt4
15.	Kt to KB3	15. R to Kt1 (*e*)
16.	P to KKt4 !	16. R to Kt3 ?
17.	KR to Ktsq	17. R to Kt2
18.	Kt to Kt5	18. P to KKt3 (*f*)
19.	P × P	19. KP × P
20.	Q to Kt2 !	20. Kt to K2 (*g*)
21.	P to KR4	21. Q to R3 (*h*)
22.	P to R5	22. R to QB2 (*i*)
23.	Q to R3	23. R to KB2 (*j*)
24.	P × P	24. P × P
25.	R to R1	25. K to Bsq
26.	Kt × R	26. K × Kt
27.	Q to R7ch	27. K to Bsq
28.	Q to R6ch	28. K to Ksq
29.	Q to R8ch	29. K to Q2 (*k*)
30.	P to B3	30. B to Kt2
31.	R to R7	31. B to Q4
32.	P to Kt3	32. Q to R4
33.	P to K6ch !	33. K to B3 (*l*)
34.	Kt × Pch	34. K to Kt2
35.	Kt × QKtP	35. R to Bsq
36.	Q to K5 and wins	

NOTES.

(*a*) The objection to this otherwise strong move is that it leaves the Queen's side very weak. Black should not reply 7. . . . P to KKt3, because of 8. P to KR4.

(*b*) Again best. If 8. . . . P to QB4, 9. Q to R3 !, P to KKt3, 10. P × P, followed by P to KB4.

(*c*) Usual in similar positions, but the safer course perhaps is 9. Q to K2, P to B4 ; 10. P × P, QKt to B3 ; 11. Kt to B3 (best), B × P ; 12. Castles (KR), &c. ; 9. Q to Kt3 also has points.

(*d*) For now we think that 11. . . . Q to R4 should give Black the advantage. Next move is too late.

(*e*) He would do better by 15. . . . Kt to Kt5, 16. Kt to Bsq, B to Q2.

(*f*) 18. . . . P to KR3, 19. P × P ; P × P seems better. Of course he could not take the Knight at once.

(*g*) This shuts out the Rook, but he cannot play 20. . . . Q to B2 on account of the check with the Queen.

(*h*) 21. . . . P to R4 is no good. White would reply Kt to Kt3 and take the Pawn.

(*i*) The game is now hopeless ; he gets no time for . . . B to K3, which he seems to intend.

(*j*) After 23. . . . B to K3, 24. P × P, Q × Pch ; 25. K to Bsq, Q to R8ch ; 26. K to Q2, B to Kt5ch ; 27. Kt to B3 (!), Black's game is lost.

(*k*) He should have avoided going to this file.

(*l*) Clearly K × P loses a piece. If B × P, White gains time by Kt × P, for if then 34. . . . B × Kt, 35. B to Bsq. Dr. Tarrasch conducted the whole game with great vigour. Herr Walbrodt missed his chance on the eleventh move, and gradually drifted into a hopeless position.

CHESS INTELLIGENCE.

Herr Mieses, of Dresden, is playing a match at Paris with M. Janowsky, of that city. The present score is Janowsky, 3 ; Mieses, 2 ; drawn, 1.

The now annual Christmas tournament at Craigside, Llandudno, took place the week after Christmas. In the principal cup competition there were seven players, Mr. Herbert Jacobs, of London, coming out first, with the fine score of six wins ; Rev. J. Owen, and Mr. W. H. Gunston, of Cambridge, tied for second place with a score of 4 ; Mr. Porterfield Rynd, the Irish champion, who had won the cup on the two previous occasions, was not placed this time.

The result of the adjudication on the Surrey *v.* Sussex match was an even score. Should both counties win their remaining matches in the S.E. district, the match will have to be replayed.

The Hastings Chess Festival took place on January 17th, 18th, and 19th. The programme, as usual, consisted of simultaneous exhibitions and consultation games. This year a blindfold exhibition by Mr. Blackburne was added to the programme. The results will be given next month.

It is said that Herr C. von Bardeleben, of Berlin, will shortly play matches with Mr. Blackburne at Hastings, and with Mons. Tschigorin at St. Petersburg.

Negotiations are in progress for a cable match between the Manhattan Club, New York, and the British Chess Club, London. The number of players a side is not yet settled, the London club preferring a larger number than the five proposed by New York. The match will probably take place in February, and will be played at one sitting with a time-limit of twenty moves an hour.

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NOTICES.

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